LECTURES ON APPENDICITIS

NOTES

LECTURES ON APPENDICITIS

AND

NOTES ON OTHER SUBJECTS

BY

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PREFACE.

EIGHT years ago, when there was confusion in antiseptic methods of wound treatment, I presented a little book, which was accepted because it told of one way for accomplishing certain ends. At the present time, while there is confusion of ideas on the subject of appendicitis, it is perhaps a favorable time for blazing one clear trail through the subject in a similar way. In the matter of operative procedures, I have due respect for methods which are different from my own, believing that in the art of surgery every surgeon is a law unto himself, and that he knows the factors of his own success. This collection of lectures includes the substance of my teaching on the subject of appendicitis at the Post-Graduate Medical School in New York, and I have added a series of notes on other subjects which have received little attention in literature, but which have interested my class.

The terms local leucocytosis and phagocytosis I have used synonymously, pending further investigation. The substance of many of the notes has appeared in various periodicals—*e.g.*, the *New York Medical Journal* and *New York Medical Record*, the *Annals of Surgery*, the *New England Medical Monthly*, the *Post-Graduate*, the *Transactions of the American Association of Obstetricians and Gynecologists*, *Transactions of the Southern Surgical and Gynecological Association*, *Transactions of the American Medical Association*, *Transactions of the International Medical Congress at Berlin, 1890*, *Transactions of the New York State Medical Society*, *Transactions of the Pan-American Medical Congress*.

Aid in research work was given by Dr. Arnold Eiloart and C. N. Haskell, in chemistry; and by Drs. J. C. Smith, H. T. Brooks, and William Vissman, in pathology. Dr. J. C. Smith furnished the photo-micrographs, and the illustrations from my specimens and dissections were made by Dr. Henry Macdonald.

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CHAPTER I.

PREPARATION OF SURGEON AND PATIENT.

General Cleanliness is obtained by washing our hands, and the skin of the patient, at the proposed field of operation, with ordinary soap and water, aided by a nail-brush.

Special Cleanliness for the surgeon and assistants is gained by immersing the hands in 1:2000 bichloride of mercury solution for five minutes in preparation for ordinary work. Theoretically, this does not completely sterilize the hands, but practically it has been sufficient in my experience. It is difficult to destroy absolutely the spores of some of the bacteria, but if the whole operation is properly conducted, we need hardly fear the few spores which resist the action of the bichloride on our hands. After operation upon a distinctively septic case, and before proceeding to the next one, the hands are prepared by immersing them in a solution of permanganate of potassium, one drachm to the pint, until they are deeply stained, and then bleaching them in a solution of oxalic acid, two drachms to the pint, and afterward rinsing in 1:2000 bichloride of mercury solution.

Special cleanliness for the skin of the patient is obtained by methods employed for cleansing the hands, but, in addition, the skin is always shaved first, and, if possible, a pad of moist bichloride gauze is kept in contact with the skin at the proposed field of operation for ten hours.

Special cleanliness of the alimentary canal of the patient is aimed at by emptying the bowels, and then giving five grains of salol. This is an important measure in abdominal work, because the process of digestion stops when the abdominal sympathetic nerves are shocked, and fermentation ensues, poisoning the patient with saprophytic products. Salol lessens fermentation.

Instruments are sterilized by boiling for ten minutes in 1:100 bicarbonate of sodium solution. The boiling sterilizes, and the bicarbonate of sodium prevents oxidation of the bright metal and of the cutting edges. At the time of the operation, instruments are allowed to remain, while not in use, in boiled water.

Towels are sterilized by boiling for ten minutes just before using, if they were boiled for half an hour after use at a previous operation.

Sponges.—Reef sponges, costing less than two dollars a pound, are used in my work. They are soaked in warm water for a day to soften the dry sarcode which covers the spicules. After a general washing, they are placed in hydrochloric acid solution, one part to ten, and left there until all shell sand is dissolved. Ten hours will suffice for some of the sponges, but an addition of acid will be necessary if the original amount is used up on excessively abundant lime salts. The cleansed sponges are placed in permanganate of potassium solution, 1:100 for ten minutes, and are afterwards rinsed before going into the bleach bath of oxalic acid solution, 1:30. As soon as they are white, a few minutes' immersion being sufficient, the ones that are wanted for early use are immersed in 1:4000 bichloride of mercury solution, containing glycerine in the proportion of one ounce to the pint, and they are left in the solution for ten hours. After being squeezed dry, they are placed in glass jars ready for use. Sponges that are not to be used for several months are stored dry, tied up in paper bags. A repetition of the treatment, minus the hydrochloric acid, will answer for sponges that have been used. The permanganate of potassium combines with the organic sarcode, and stains the inorganic spicules, acting as a germicide. The oxalic acid decomposes the potassium compounds, and is destructive to bacteria and their spores. The bichloride of mercury acts further as a germicide, and glycerine is employed because it is hygroscopic, and prevents for several weeks the change of the bichloride of mercury to calomel—a change which occurs rapidly when dry bichloride is exposed to the air in thin layers over the spicules. If a strong solution of bichloride of mercury is used, it makes the sponges too hard.

Gauze.—Absorbent gauze, which constitutes the principal bulky dressing, is prepared by boiling cheesecloth or mull in a solution of carbonate of sodium (washing soda) 1:16, for two hours: changing the water, rinsing, and boiling again in the same solution for

two hours, then rinsing and boiling in pure water for ten minutes. The gauze is then absorbent, because the soda has saponified the fat and broken up the gummy elements of the cotton fibre. The gauze is finally washed in clean boiling water, and immersed in 1:2000 bichloride of mercury solution, containing one ounce of glycerine to the pint. After squeezing dry, the proportion of the lot that is likely to be used in less than two months is stored in glass jars, but the remainder, as with the sponges, should be securely tied up in paper bags, and again immersed in bichloride and glycerine before being placed in the jars for early employment.

Iodoform Gauze is not used in my clinic for wound treatment, because the iodoform and the fixing agents interfere with the capillarity of the gauze, and thereby destroy the nice mechanical action which is the chief and great virtue of gauze dressings.

Absorbent Cotton can be prepared from cotton batting by the process employed for gauze, and it makes a much cheaper dressing, but the absorbent cotton does not look attractive unless it is re-carded after treatment, and on that account is not often manufactured by the surgeon at home. If the absorbent gauze and cotton are purchased from dealers, each lot must be tested separately, because a patient's life is often staked absolutely upon the capillarity of a filament of gauze, and I have bought alleged absorbent dressings which would have betrayed the patient's trust in me. Test absorbent gauze and cotton by dipping one end of the filament of prepared and unprepared stuff, side by side into a glass of warm water. The water will be seen to shoot up into the absorbent stuff instantly.

Drainage Apparatus.—Drainage is not often required for aseptic wounds, but it has a place of vital importance at times. I depend almost entirely upon the drainage wick, made by rolling absorbent gauze in gutta-percha tissue, very much as one rolls tobacco in a cigarette paper. The average wick is about the diameter of a cigarette, but longer. (See article on Drainage Wick.)

Sutures and Ligatures.—Silk is used by me in one place only in surgery, and that is for ligating the inner tube of the appendix. The tiniest of buried knots is desirable at that point, and the finest strand of silk answers the purpose well. The silk is boiled for half an hour, and then stored on a glass rod in a glass tube filled with alcohol.

Catgut.—Catgut is the ideal material for sutures and ligatures, if prepared according to the following directions: Every surgeon

must attend personally to the preparation of his catgut. No matter how good the intention of the dealer, the work is sometimes given to workmen who do not know what responsibility they are to share with the surgeon, and the patient's needle may turn on a pivotal suture. I buy from L. H. Keller & Co., 64 Nassau Street, New York, the hanks of raw catgut in the form known as "bow-lines." Each bow-line is one metre in length, and the form is convenient because a few strands can be removed from the storage bottle and placed in a saucer of alcohol at the time of the operation, thus avoiding the danger of contaminating the mass remaining in the storage bottle. Different dealers number their sizes of catgut arbitrarily, and in order to establish a standard I have proposed that the American Standard Wire Gauge be used. Such a gauge can be found in almost any mechanic's shop, and there is no good reason why catgut should not be measured by this standard. The sizes that are employed for almost all of my work are No. 25 and No. 20, American wire gauge. The hanks of raw catgut are placed in a glass jar and freely covered with commercial sulphuric ether, in which they remain for a week. The ether removes the fixed oil, and acts as a germicide, becoming very foul, however, and unfit for further use. The foul ether is poured off at the end of a week, and fresh ether containing bichloride of mercury, in the proportion of 1 : 4000, is added. After standing in this new ether for a week, the hanks are transferred to a storage bottle of absolute alcohol, containing bichloride 1 : 4000, and are ready for use, unless the chromicizing process is preferred. I use chromic gut altogether, because smaller sizes of this will take the place of clumsy strands of simply prepared gut. To chromicize the catgut, it is first prepared by the simple process, and is then placed in a solution of bichromate of potassium and alcohol, fifteen grains to the pint, first dissolving the bichromate in one ounce of distilled or boiled water, and adding it to the alcohol in the form of a watery solution. The catgut remains in the solution of bichromate of potassium and alcohol for fifteen hours, and is then drained, and placed in absolute alcohol for storage. The chromicizing process doubles the resistance to absorption of the catgut in the tissues. When first prepared, the resistance is not quite doubled, and after standing in the alcohol for a year, it is rather more than doubled ; but this variation is of little practical importance. Catgut left in the bichromate of potassium solution for more than fifteen hours be-

comes too resistant, and may not be absorbed in months. Prepared for fifteen hours in the fifteen-grain-to-the-pint solution, No. 25 is absorbed in about ten days, and No. 20 in about twenty days. At the time of the operation, a sufficient number of bow-lines are removed from the storage bottle, and placed in a saucer of alcohol ready for immediate use. Any bow-lines left over after the operation are thrown away. After preparing a lot of catgut, it is tested by cutting up a strand, placing the pieces in boiled distilled water for ten minutes, and then planting the pieces in a test tube of agar-agar.

Irrigating Solutions.—The only irrigating solutions that I employ are physiological saline solution and strong hydrogen dioxide.

Hydrogen Dioxide is used in full strength for flushing septic cavities at the time of the operation, and is then washed out with the physiological saline solution. The dioxide of hydrogen is a powerful germicide, and it not only destroys the bacteria, but throws up pus and septic fluids in a foamy mixture, which is easily washed away. The same antiseptic is used in many septic cavities after operation until granulation begins, but we must discontinue its use then, as a rule, because the peroxide follows leucocytes into granulation tissue, and thus delays repair.

Physiological Saline Solution, representing the normal proportion of chloride of sodium in the blood, is the least irritating and the most useful general irrigating solution. It is made by boiling ninety grains of chloride of sodium in one quart of water.

Common Boiled Water irritates the tissues, and is somewhat corrosive, as may be observed by dropping it on the eye, or placing a glistening piece of peritoneum in it for an hour. Water in the eye causes smarting, and it dulls the surface of the peritoneum. In a peritoneal operation it injures the serosa slightly, and may cause vexatious little adhesions afterward. The injury to the serosa may be sufficient to close the mouths of the lymphatics upon which the surgeon depends for very important aid in carrying off septic matter. Therefore unsalted water should not be used for irrigating purposes.

Chemical Antiseptic Solutions are still more irritating than plain water. We depended upon them until progress carried us to aseptic surgery. Physiological saline solution is used for all ordinary purposes of irrigation in surgical work, and it is practically unirritating. The sponges are kept in basins of it at an operation,

and the surgeon's hands are washed in it for neatness' sake while he is at work.

Aristol.—Aristol is similar to iodoform in its action, but it is preferable to iodoform because it adheres to tissues much more tenaciously, because it seldom, if ever, produces any toxic effects, and because it smells better. Aristol is not directly an antiseptic, but it quickly forms with lymph a thin protecting coagulum which is almost impenetrable to bacteria. The free iodine which is given off, destroys irritating ptomaines, and allows leucocytes to marshal their forces on one side of the coagulum wall, while bacteria are making slow progress from the other side. Aristol is of the utmost importance in closing tissue planes against infiltration from a wound. For instance, after supra-pubic cystotomy, it will make a fine impenetrable wall about the drainage track. It will do the same thing after the removal of the gangrenous appendix, or a pus tube, and it makes very simple the question of drainage after operations upon the gall-bladder and bile ducts. The comfort that I find in the use of aristol according to a proper technique is very decided. The drug must be studied with reference to its use in forming a thin protecting coagulum. Aristol is apparently not absorbed readily in the tissues, but it becomes harmlessly encapsulated. In rabbits upon which I experimented, and in operations upon patients in whom I had previously employed it for preventing secondary peritoneal adhesions, the aristol was found encapsulated in little spots, retaining its color, and producing an appearance which will puzzle pathologists who come across it without knowing that aristol has been used in the case.

FIG. 1.
Culture Tube.

A, cotton plug.
B, swab carrier.
C, swab.
D, agar-agar.

Aprons.—A very thin and light apron of rubber dam with rubber tube strings, is made for me by John Reynders & Co., of New York. These aprons can be packed in very small space, and they are boiled and otherwise cleansed with ease. One of the aprons rolled over a rope, and leaving half of the apron free, can be tied about the waist of a patient in Trendelenburg's posture. Used in this way it keeps the clothing of the patient dry, and conducts fluids into a proper receptacle.

Culture Tubes.—Four or five culture tubes of agar-agar are carried in a little case in my instrument bag. A swab fastened to a copper tube rests in the tube, not quite touching the culture medium. The mouth of the tube is filled with scorched cotton. At an operation in which it is interesting to note what species of

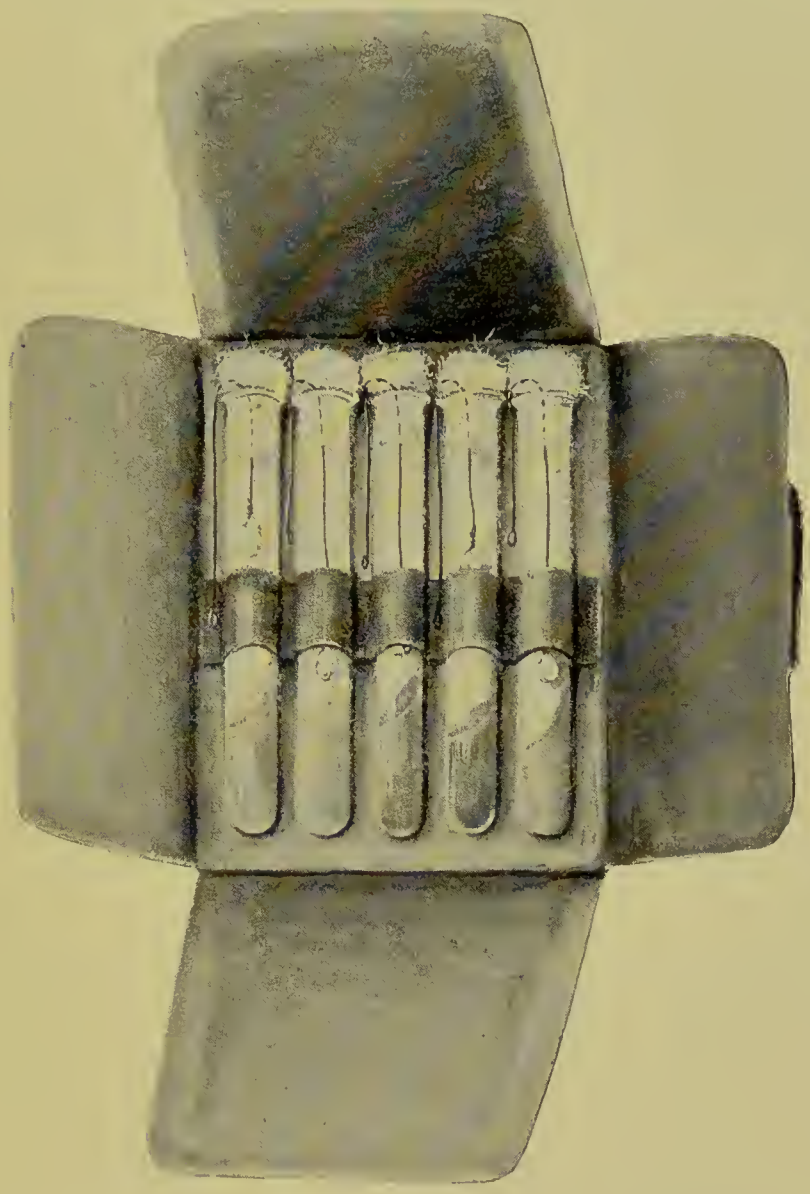

FIG. 2.—Portable set of culture tubes for the surgeon's bag.

bacteria have been at work, the swab is touched against the infected tissues, and then carried to the agar-agar. The swab is then thrown away, and the mouth of the tube again plugged with scorched cotton, after which the tubes are handed to the bacteriologist for further investigation.

Results.—The efficiency of the comparatively simple resources above described is shown very well in one of the hospitals at which I have none of the complete advantages which are furnished at our Post-Graduate Hospital, and in other hospitals in New York, where my patients receive elaborate preparatory treatment and detailed after-treatment under my personal supervision. I refer to the Ithaca City Hospital, which is a transformed wooden dwelling-house, having meagre advantages as a hospital. Almost none of my patients there received any preliminary treatment, but were prepared on the day of the operation, and frequently on the operating-table only. I saw most of these patients for the first time then, and not again afterward. The medical staff consists of a large number of physicians and surgeons, and yet during a period of two years there has been but one death among the surgical cases at that hospital in the service of any of the operators. That death occurred after a hip-joint amputation in one of my patients who had suffered for years with suppuration from the whole length of the femur, following osteo-myelitis, and who had amyloid kidneys and puffy feet on the day of operation. I am at liberty to give my own statistics only. From the hospital years February 6, 1893, to February 6, 1895, I operated upon the following 193 cases, in 178 patients, at the Ithaca Hospital. No patients were refused operation excepting hopeless cases of carcinoma and sarcoma, and exploratory operations were done in five cases of this sort to determine if an involved organ, such as the gall-bladder or intestine could possibly be operated upon with a prospect of benefit to the patient.

Acute appendicitis ; perforation of cecum ; abdomen distended with pus and gas, not encapsulated	1
Acute appendicitis ; perforation opening into abscess cavities, encysted	4
Acute appendicitis ; mucosa desquamating	1
Chronic appendicitis ; various adhesions and complications	11
Typhlitis, perforative ; abdomen full of sero-pus	1
Abdominal hysterectomy for very large myomata and fibromata	6
Abdominal hysterectomy for a placental hemorrhage	1
Vaginal hysterectomy for cancer, 1 ; procidentia, 1 ; chronic metritis, 3	5
Abdominal hystero-pexy for retroversion of uterus	5
Abdominal hystero-pexy and removal of destroyed adnexa	6
Removal of large ovarian cysts	6
Celiotomy for conservative treatment of adherent or diseased adnexa of the uterus, non-suppurative	7
Celiotomy for removal of pyogenic oviducts	2
Exploratory celiotomy to determine if malignant growths could be operated upon.	5
Gastrorrhaphy for chronic dilatation of stomach	1
Bassini's operation for hernia	2

Macewen's operation for hernia	1
Closure of ventral hernial opening	2
Supra-pubic cystotomy, stone, 1 ; tuberculosis, 1 ;	2
Nephrorrhaphy for loose kidney	3
Removal of navel for eczema	1
Removal of breast and axillary glands for cancer	11
Repair of rupture of perineum	7
Repair of perineum and cervix simultaneously	3
Repair of cervix	2
Removal of decomposed fetus 5 months (vaginal route)	1
Von Bergmann's hydrocele operation (excision of sac)	4
Lister's varicocele operation (excision of veins)	14
Ligature of dorsal vein of penis for impotence	2
Excision of varicose veins of leg	1
Circumcision for phimosis	6
Amputation of penis for cancer	1
Internal urethrotomy for stricture	9
Removal of sphacelus of bone, tibia, 2 ; femur, 1 ; maxilla 1	4
Amputation of forearm	1
Re-amputation of leg	1
Hip-joint amputation (death immediately, shock)	1
Amputation of thumb for sarcoma	1
Suture of fractured ulna	1
Tenotomy for talipes	2
Excision of tuberculous tendon of biceps brachialis	1
Suture of cut tendons of hand or wrist	3
Suture of dislocated acromial end of clavicle	1
Ligation of hemorrhoids	4
Obliteration of fistula in ano	5
Coccygectomy for coccygodynia	2
Removal of sarcomatous neuromata, ulnar, 2 ; circumflex, 1 ; peroneal, 1	4
Removal of melano-sarcoma of brachial region	1
Mastoid bone opened for evacuation of abscess	1
Incision for periostitis of tibia	1
Extirpation of tuberculous inguinal bubo	1
Extirpation of tuberculous mass of cervical glands	3
Extirpation of coccygeal dermoid cyst	2
Extirpation of vulvar fistulous tract for embedded hair-pin	1
Extirpation of hypertrophied tonsils, child, 1 ; adult, 1	1
Plastic operation after removal of cancer, lip, 3 ; cheek, 2	5
Poncet's operation for goitre	1
Removal of cancerous glands of neck	2
Removal of branchial cyst of neck	1
Removal of large fibroid tumor of neck	1
Plastic operation on anus, incontinence stricture	3
Fracture and replacement of deviated nasal septa	2
Removal of extensive papilloma of anal region and buttocks	1

Whole number patients, 178 ; Operations, 193 ; Deaths, 1.

The reduction of a general surgical death-rate to a fraction of one per cent. under such circumstances is due to the resources of to-day rather than to any particular skill on my part.

CHAPTER II.

THE APPENDIX VERMIFORMIS CECI.

THE lengthened cecum of mammals has degenerated to a vermiform appendix in some species. The cecal appendage is vermiform in man and in all of the man-like apes—gorilla, orang, chimpanzee, and gibbon (several species). It is also vermiform in certain lemurs, and perhaps in some of the monkeys. Curiously enough the marsupial wombat has a vermiform appendix. In

FIG. 3.—Normal appendix vermiformis ceci (*Homo sapiens*) showing mesappendix and solitary artery.

man, the cecal appendage is apparently a rudimentary structure which once formed an important part of the alimentary tract in the days when we needed a wisdom tooth for crushing palms and ferns, and a large absorbing surface for extracting their scanty

nutriment. Now, as degenerate structures, the cecal appendix, and the wisdom tooth, with its insufficient calcification, perish easily when attacked by bacteria. The microscope does not show the comparative vital energy of different cells or structures, but it is fair to assume that the unused appendix has low vitality, because we know analogously that other unused normal structures lose to a certain extent their resistance to infection by bacteria.

The appendix vermiformis in man was recognized as a structure in the sixteenth century, and was described in the eighteenth century. It appears at about the tenth week of fetal life. As compared with the length of the colon, it is largest at birth, and smallest after seventy years of age. It is one of the structures which flutters before going out in the descent of man, and is consequently of extremely variable dimensions. The length of an average appendix vermiformis in a young adult is not far from three and three-quarter inches, with a diameter of the quill of the primary feather from the wing of a Canada goose. We occasionally find a normal appendix two inches long, or eight inches long, and I have removed several which were about half a foot long. Measurements taken *post mortem* will give too great an average length, because the appendix becomes lax and elongated after the period of rigor mortis has passed. Measurements taken from specimens removed at operation will give too short an average length, because the structure contracts almost immediately on separation from the cecum, unless it is gangrenous or tense with exudates. We must therefore make our estimates from normal appendices observed while we are engaged in other abdominal work.

The position of the appendix is usually behind the cecum, and pointing toward the spleen, but its tip may touch almost all boundaries of the peritoneal cavity. It is ordinarily supplied with a mesappendix, which is given off from the left layer of the mesentery of the ileum. There is good authority for the statement that the appendix is sometimes extra-peritoneal, but in all observations by myself, in which structures were not too badly damaged for accurate determination of that point, the appendix possessed a mesappendix. This is a matter of little practical importance to the surgeon, because an appendix situated behind the peritoneum could be easily released by a slit through the peritoneum at that point.

A transverse section of the appendix shows it to consist of the structures which belong to the cecum, but with an excess of lymphoid tissue, amounting in some cases to half of the entire mass. From without inward, the layers are: peritoneum, external non-striated circular muscle, internal non-striated longitudinal muscle, lymphoid tissue, and mucosa. This does not include the connective-tissue layers, the most important of which, lying between the lymphoid tissue and the longitudinal muscle, becomes so greatly distended with serum as to form a strong factor in exudate strangulation of the lymphoid layer in some infected appendices.

The principal arterial supply of the appendix is from a branch of the ileo-colic artery, which passes along the free margin of the mesappendix. This artery may be described as the solitary terminal artery of the appendix, and its anatomical arrangement is a matter of great clinical importance. In some women the appendix receives a little collateral circulation by way of the appendiculo-ovarian ligament.

The lymphatics of the appendix pass largely to a ganglion at the cecal extremity. The nerves of the appendix are from the superior mesenteric plexus of the sympathetic system, which is widely distributed to the small intestine, and this explains the reason why patients often suffer from colic and general abdominal pain, or pain at the navel, without realizing that its origin is at a little part of the whole, at the appendix (Fowler). It is almost an exception for the pain to be localized at the vicinity of the appendix at the outset of an attack of appendicitis.

The contents of the appendix usually consist of mucus with more or less fecal matter. Under ordinary circumstances semi-solid fecal matter and gas find easy entrance to and exit from an appendix with a large lumen, as the appendix has abundant muscular ability to empty itself, and it has at the cecum a good fixed point for muscular action. It is not an uncommon sight when we are employed in abdominal work to see an appendix empty itself of distending contents when it is stimulated to contraction by the touch of the surgeon's finger. Although an average appendix can empty itself when in a normal condition, a very little hyperplasia or swelling of the lymphoid coat will suffice to lock in the contents of the lumen, and there are very many normal appendices containing concretions which cannot escape because the lumen is too small.

Appendix concretions are of three principal sorts—fecal, phosphatic, and fatty. Fecal concretions are formed in normal appendices by the action of the muscularis rolling a bit of fecal matter into a ball or rod, which is cemented with mucus. Insoluble salts are precipitated out of the fermenting mucus, and as stagnant mucus is very apt to undergo decomposition, the fecal concretions are usually arranged in layers, alternately or

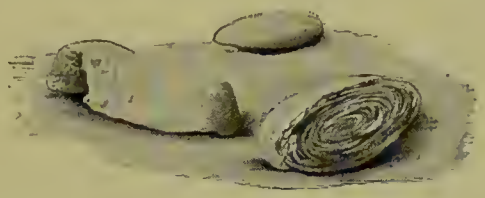

FIG. 4.—Phosphatic appendix concretions.
One bisected, showing concentric layers.

homogeneously, with calcium salts. Phosphatic concretions are formed in normal appendices, and in chronically infected appendices as a result of decomposition of mucus. Phosphate of calcium is the common, and sometimes the only ingredient of a concretion which may become as large as a hickory-nut. Examination of three typical phosphatic concretions from three chronically infected appendices gave the following results:

(1) Patient had repeated slight attacks of appendicitis; concretion about as large as a No. T shot; color, brown; external layer and internal portion of neutral calcium phosphate, with traces of organic matter and potassium; no magnesium or oxalic acid.

(2) Patient had repeated attacks of appendicitis, some of the attacks violent. Concretion was of the size and appearance of a date seed; grayish-brown in color; external layer as in specimen No. 1; internal portion contained more organic matter.

(3) Patient had repeated violent attacks; concretion size of robin's egg; of a whitish-clay color; external layer and internal portion composed of fifty per cent. of fat; the remaining fifty per cent. consisted of alkaline calcium phosphate.

I was at a loss to account for the large proportion of fat in this and in other similar calculi, but it seemed possible that fatty metamorphosis of lymphoid cells in a chronically ulcerating appendix might furnish enough fat to make a concretion, and the following analyses were accordingly made, the inner tubes com-

posed of mucosa and submucosa from three sets of appendices being used:

(1) *Four normal appendices.*

Inner tubes dried at 100° C., weighed	1.0095 gm.
And yielded fat weighing	0.0860 "
Percentage of fat	8.52

(2) *Three appendices with small ulcerating areas.*

Inner tubes dried at 100° C., weighed	0.7276 gm.
And yielded fat weighing	0.1410 "
Percentage of fat	19.38

(3) *Three appendices with extensive chronic ulceration.*

Internal coats dried at 100° C., weighed	0.6580 gm.
And yielded fat weighing	0.1701 "
Percentage of fat	25.85

The inner tubes of the normal appendices weighed dry 9.2 per cent. more than those of the ulcerating appendices, but contained only about one third as much fat.

Several observers have reported the finding of gallstones in appendices, but these specimens were probably appendix stones. Even though the composition of the concretions was largely cholesterin, it is a tenable belief that they were formed in chronically ulcerating appendices. There is a theory extant to the effect that gallstones are formed in the gall-bladder by the precipitation of their constituents by colon bacilli, the bacteria which are constantly present in ulcerating appendices. Appendix concretions are round, oval, flat, or rod-shaped. Some of them occur singly, and some of them in such numbers as to make the appendix look like a rosary. Various kinds of seeds are closely simulated by these concretions, and this accounts for the popular error that seeds are apt to get caught in the appendix. The deception is all the more complete when the appendix mucus becomes condensed, and rolled into yellowish prolongations from the concretions, giving almost exactly the appearance of a sprout from a seed. I have not as yet found a seed in any of the appendices from my series of cases, the nearest approach to one being a small piece of apple core encrusted with phosphates. The formation of fecal and phosphatic concretions, while more apt to

occur perhaps in patients whose intestinal contents ferment, may be independent of any disease of the appendix; but fatty concretions probably occur only as a result of long ulceration of the lymphoid coat.

Bacteria are by all means the most important things found in the appendix. The colon bacilli which have their normal habitat in the colon are almost invariably present in the lumen of the appendix, and they are harmless dwellers there unless an infection atrium gives them an opportunity to migrate into the tissues. The pyogenic streptococci are also pretty constant dwellers in the normal appendix. Many of the less important pyogenic bacteria and saprophytes, or bacteria of fermentation, harmlessly lurk in the nook of the appendix awaiting the advent of conditions which will be favorable for their rapid multiplication. When an infection atrium is made, the infection is at first mixed in character, as observed in a number of my specimens of infected appendices which were removed in the very early stages of appendicitis. The streptococci are apt to outstrip other bacteria in the second part of the race, and the colon bacilli are apt to lead finally. Thriving colonies of bacteria are daily swept along through the normal colon, and are moved out of most appendices; but we must always look at the appendix as a test tube full of culture media, and forming a nook in which bacteria lurk dangerously when once the protecting structures of the appendix have been disabled. Some of the higher entozoa are frequently found in the appendix, and the nematode oxyuris is fond of making it a nest.

CHAPTER III.

APPENDICITIS.

ACCORDING to my observations to date, appendicitis is an infective, exudative inflammation of the appendix vermiformis ceci, originating in any local cause for the production of an infection atrium in the tissues of the appendix, and progressing by bacterial invasion into the layers of connective tissue, and the layer of lymphoid tissue, all of which are partially or completely disabled by interstitial exudate compression within the narrow

FIG. 5.—Section of air-distended normal appendix.

FIG. 6.—Section of infected appendix which was becoming disabled from interstitial exudate compression.

muscular and peritoneal sheath of the appendix. The principal cause for appendicitis is mixed bacterial infection from the lumen of the appendix. The chief cause for bacterial infection from the lumen of the appendix is the formation of an infection atrium in the mucosa of the appendix by force applied in any way. I formerly surmised that the appendix was sometimes injured by pressure between a full cecum and the hard pelvic wall, supposing that the cecum was often filled with fecal matter; but after extensive opportunities for observation, I have not as yet seen fecal

matter in the cecum at any operation, and there is doubt if so-called impaction is not often lymph exudate instead. Excepting in elderly people I believe that injury to the mucosa occurs most often from accidental twisting of the appendix upon part of its long axis. An infection atrium is also commonly produced by erosion of the mucosa at the site of a concretion, or by entozoa. Bacterial infection may extend into the tissues of the appendix from an infected cecum, as in typhoid fever or dysentery. An infection atrium is formed in its peritoneal outer wall at times by destruction of serosa consequent upon peritonitis extending from adherent infected oviducts or other near-by structures.

The principal structures involved in appendicitis may be grouped as follows: (1) a soft, distensible inner tube of mucosa and lymphoid tissue within a confining outer tube of muscle and peritoneum; (2) lymphatics leading to the lymphatics of the colon and mesentery; (3) veins leading to the superior mesenteric vein; (4) a solitary terminal artery; (5) connective-tissue planes; and (6) nerves belonging to the mesenteric plexus.

The above definition and brief statement of the salient points needs some repetition and elaboration. The mechanical feature of interstitial serum pressure appears as soon as bacteria have entered an infection atrium—the term applied to any gateway which gives entrance for bacteria to the tissues. The toxines which are the products of bacterial growth are irritating, and as a result of their invasion, serum is exuded into the tissues of the appendix, placing such tissues under the influence of serum compression. The lymphoid coat of the appendix and its connective-tissue cushion, forming the principal part of the inner tube of the appendix, are so much like the faucial tonsil, that I shall take the liberty of speaking of the one as the tubular tonsil, and of the other as the flat tonsil, for purposes of illustration. The flat tonsil and its connective-tissue cushion can swell enormously because there is a whole pharynx to give room to them. Even then the flat tonsil sometimes fills the throat and its connective-tissue cushion sloughs. The infected tubular tonsil and its connective-tissue cushion try to swell just as the flat tonsil does, but they are promptly subjected to pressure within the narrow confines of the muscular and peritoneal tube of the appendix. The imprisoned tube is then further compressed by contraction of the muscular coat upon the inner tube, in tonic spasm, as a result of toxic stimulation of the branches of Auerbach's plexus. Over-stimula-

tion of these branches leads to tonic contraction of the muscularis at the appendix. Stimulation extending to the branches of Auerbach's plexus at other parts of the intestine leads to irregular spasm, giving the symptom known as colic, and if over-stimulation of the sympathetic system extends still farther, the vaso-motors cause the heart to contract rapidly in partial spasm, and the heart muscle being unable to relax completely, muscular spasm of the arterioles being also present, the result is a small, rapid pulse. The tonic spasm of the outer tube upon the inner tube of the appendix is very much like putting a tight thimble upon a finger which is already tense from a felon, with serum exudate under the periosteum. The inner tube of the appendix is composed of the same

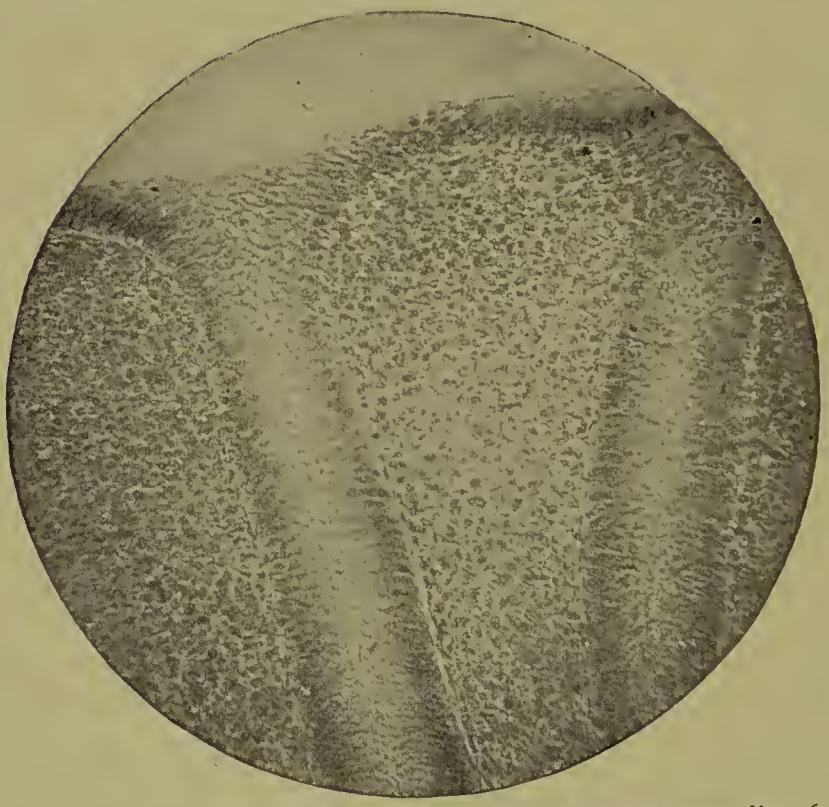

FIG. 7.—Section of normal mucosa and lymphoid layer of appendix x 600.

structures as the inner tube of the cecum, but in the cecum there is abundance of room, and the lymphoid coat continues its function as a strainer for bacteria, even when tense with interstitial exudates. The inner tube of the appendix, on the other hand, anemic from compression, cannot strain out bacteria well, and its cells readily undergo toxic destruction from bacteria. The infected appendix with its lymph and blood circulation obstructed, is not reached in men by a collateral circulation which can bring

poly-nuclear leucocytes to throw out nuclein, and give protection, and consequently the bacteria are free to carry on destructive processes. In some ulcerating appendices the inner tube may not be swollen enough to fill the lumen of the appendix, excepting when irritation of the muscular sheath excites tonic muscular spasm of that sheath, and then compression anemia again disables the inner tube. Although short or long periods of muscular spasm are of regular occurrence in infected appendices, we do not

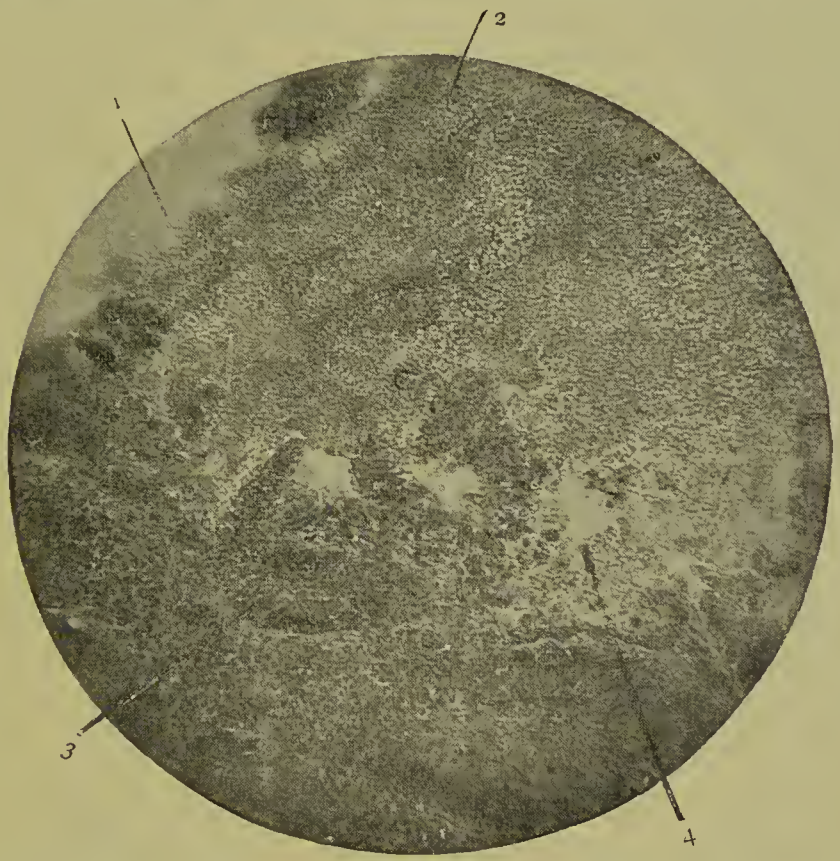

FIG. 8.—Section corresponding to Fig. 7, but undergoing acute toxic destruction.

1. Free border once occupied by mucosa.
2. Necrotic area.
3. Broken-down mucous follicles.
4. Breaking-down lymphoid tissue x 600.

need that phenomenon for the production of compression anemia in a swollen ring of lymphoid tissue, as we are all familiar with the mechanical parallel in which a swelling barrel strains against the hoops—an exaggerated illustration, but one in which the principle is the same. The attacking bacteria which are causing interstitial exudation in the appendix, with their toxines, may be called early to a halt by the processes adopted by nature for stopping the progress of bacteria elsewhere. Thus, when poly-nuclear

leucocytes can be carried freely to the place of infection, they pour out nuclein in large quantities, and it is very difficult for bacteria to pass the nuclein wall. The bacteria, confined within a small territory, then commit suicide with their own toxines, just as saccharomyces commit suicide with their own alcohol in vinous fermentation. So complete is this destruction of bacteria that an appendix lumen closed against further entrance of bacteria from the cecum may sometimes become distended with sterile serum or mucus. The appendix, however, is particularly unfitted to receive help, because when its single-artery circulation is blocked by interstitial exudates the appendix stands out as an infected peninsula, cut off from the source of protection from leucocytes, and the bacteria are at liberty to continue with their work without receiving that opposition which would meet them through a collateral circulation if the infection were in the colon. A sufficient degree of exudation compression having cut off the access of leucocytes, the toxine destruction of the inner tube of the appendix progresses to various degrees. In milder cases there is simply desquamation of patches of mucosa, but the injury is not easily repaired, and the bacteria lurking in such a disabled appendix keep up a certain degree of malign influence, sometimes for many years, though the patient be unaware of the fact. Bacteria in the lumen of the appendix are ready to make new incursions at any favorable moment, so that the appendix which has been disabled at one attack of appendicitis may be fairly said to be chronically infected afterward, because when the bacteria are not actually in the tissues of such an appendix during the interval between attacks, they are in contact with an exposed lymphoid tube, and their toxines are particularly apt to maintain a constant influence when the very common scar constrictions of the lumen of the appendix lock in septic mucus.

Acute mixed infection will cause all of the acute destructive processes which occur in the appendix, and it is not necessary to look for any specific microbe for appendicitis. I have obtained cultures of bacteria from appendices removed in different stages of progress of the disease, and although the colon bacillus was always present, the infection was regularly mixed in character at first, and in some cases up to the last point of destruction of tissues. As previously stated, however, there is a very decided tendency on the part of the streptococci and colon bacilli to outstrip all others, and finally to enter into a race with each other, the

colon bacilli usually gaining the mastery. That is why apparently pure cultures of colon bacilli are often found in the large abscesses, and in the fluid of peritonitis in far advanced cases of appendicitis, giving to such collections of fluid their disgusting fecal odor, which is really the odor of products of colon bacilli. The ordinary odor of feces is due to the harmless growth of colon bacilli in the bowel, and it was formerly supposed that the odor of appendicitis abscesses was due simply to their close contact with the bowel. It was apparent, however, that the odor of a small appendicitis abscess was sometimes out of all proportion to its size, and it was found that oviduct abscesses bearing the same relation to the bowel, and not containing cultures of colon bacilli, were free from fecal odor. Mixed bacteria and nearly pure cultures of streptococci are destructive locally, but wide infection seems to be done principally by the flagellated, far-traveling colon bacilli, which may appear in the liver or lung during an attack of appendicitis. The colon bacilli when once aroused seem like a swarm of angry bees about an over-turned hive, ready to attack anything in sight. It would be unwarrantable with our present knowledge to ascribe to the lowly bacteria anything so high as nocturnal habits, and yet it is certain

FIG. 9.—Destruction of inner tube of appendix at two points by acute ulceration.

FIG. 10.—Chronic ulceration of inner tube, from an interval case of appendicitis.

that a disproportionate number of the attacks of appendicitis among my cases came on between the hours of one and five o'clock in the morning.

The temperature of appendicitis is interesting because of its lack of importance. Though failing to indicate the extent of infection, it gives a clue, I think, to the character of the infection. Thus, the high temperatures in appendicitis more often occur when infection is mixed, or when caused by streptococci. A temperature of 103° F., or more, at the outset of an attack of appendicitis seems to mean that the toxines of mixed bacteria are sending the temperature up. When streptococci become ascendant, the tem-

FIG. 11.—Section of muscular coat of appendix, showing infiltration of leucocytes in lymph spaces.

perature may go to 105° F., but as soon as the colon bacilli control the field, the temperature of the patient may be expected to drop, and to fluctuate within a range of one degree on either side of 100° F., while the disease is in progress, and no matter how widespread the infection. The temperature in appendicitis is not often elevated after the lapse of a few hours, and a colon bacillus temperature may be normal or subnormal from the outset, and so

continue while the most disastrous effects are being produced by the bacteria in the tissues. While the toxines of the colon bacillus apparently do not send the patient's temperature up, they nevertheless pull the vital signs apart most insidiously, and it is not uncommon in cases of appendicitis with pure cultures of colon bacilli, to find a temperature averaging 99° F., and the pulse rate averaging 120 beats per minute for several days in succession. We must not look to the temperature then in trying to judge of the severity of an attack of appendicitis. But the pulse becomes important when it indicates the degree of intoxication of the sympathetic nervous system. Complete destruction of the

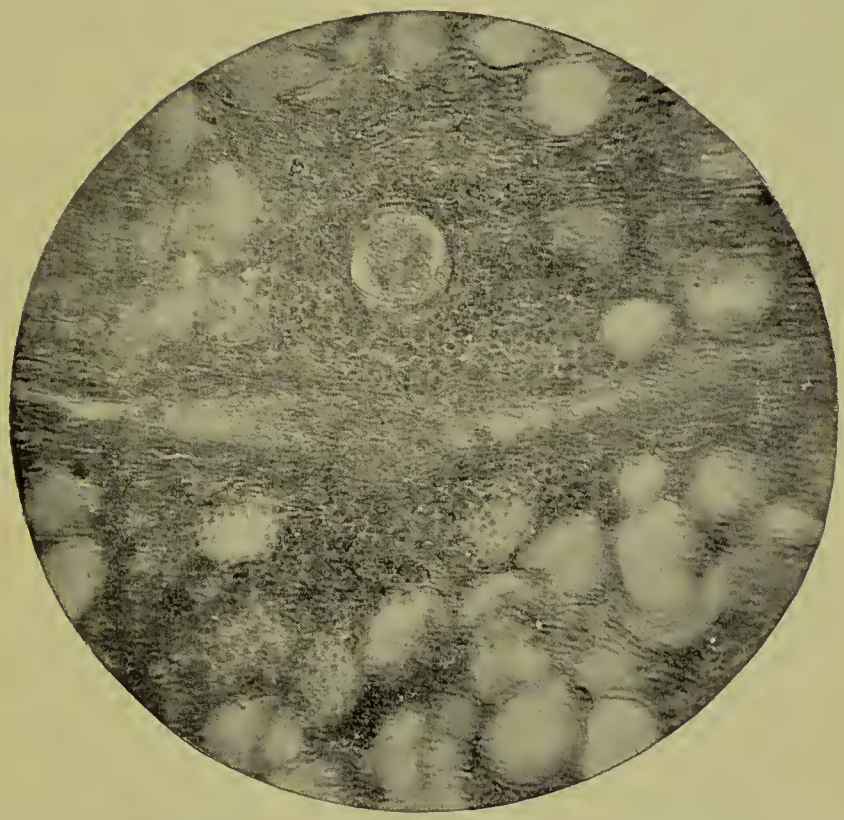

FIG. 12.—Longitudinal section of vein in mesappendix, showing thrombus surrounded by leucocytes.

walled-in appendix, however, may take place without producing much change in the character of the pulse, so that neither pulse nor temperature in appendicitis gives an indication of the extent of the destruction of the appendix proper. The lymph spaces of the lymphoid coat, together with the lymphatic vessels of the appendix and mesappendix, are often completely blocked with exudates and infiltrates a few hours after infection has com-

menced. Blocking of the lymphatic spaces interferes quickly with the lymph circulation. Infective lymphatitis frequently extends from the lymph channels of the appendix to those of the colon and mesentery. The veins of the appendix are variously thrombosed by the infection, and the process may go on to extensive mesenteric thrombo-phlebitis, pyle-phlebitis, portal embolism, and abscess of the liver. Abscess of the liver from septic appendix emboli may be looked for in almost any stage of appendicitis. The earliest case that has come under my notice occurred on the fifth day. There is no doubt that hepatic abscess appears in some cases of appendicitis that are too mild to attract the attention of the physician directly to their original character, as I have found thrombi ready to become emboli in the mesappendices of such cases.

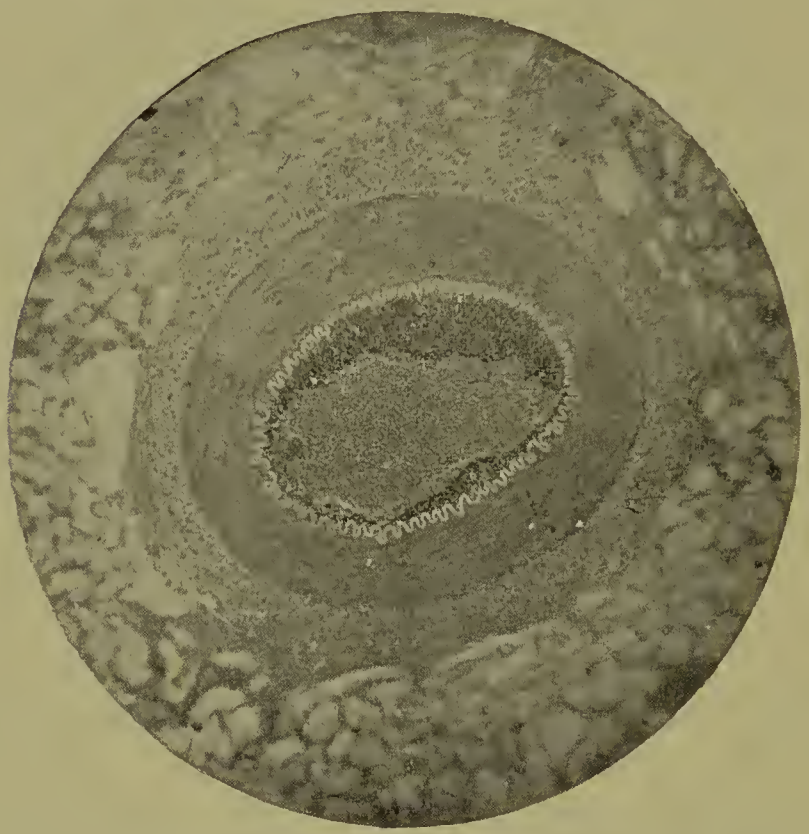

FIG. 13.—Proliferating endarteritis of solitary artery of appendix.

Arterial complications give rise to some of the most striking phenomena of appendicitis. When the solitary terminal artery of the appendix becomes the seat of proliferating endarteritis, round sloughs form at the ends of the arterial twigs that are first obliterated, or the whole appendix sloughs from deficient blood

supply. In some cases in which endarteritis causes obstruction, but not occlusion, slow ulceration occurs opposite the most affected branches of the artery. The complication of proliferating endarteritis I first described in September, 1893, but had previously examined several examples of it, finding that the tunica intima had undergone rapid proliferation as the result of acute infection. The solitary artery of the appendix is obstructed sometimes in accidental dislocation of the appendix. The expression, "dislocation of the appendix," is almost an unsafe one to use, because the appendix may occupy such a variety of positions in relation to the cecum; but when any one appendix which belongs behind the cecum is thrown out from behind the cecum by a sudden blow or by an unusual muscular effort, and when it cannot return to a position for which its mesappendix was adapted, that particular appendix may be spoken of as a dislocated one, and it may remain so strongly twisted upon itself, including the mesappendix, that arterial and venous circulation is interfered with. This, I think, is the origin of a certain proportion of cases of appendicitis. The connective-tissue planes of the appendix conduct infection to neighboring loose connective tissues, and very extensive sub-peritoneal abscesses may form, sometimes at such a distance from the appendix as to mislead the surgeon because of their simulating peri-hepatitis or peri-nephritis, or psoas

FIG. 14.—Two round sloughs.

abscess. In two of my cases, phlebitis of the veins of the left leg occurred as a result of infection travelling from the appendix across the pelvis by way of the sub-peritoneal connective tissues. In another case, an abscess formed along the left pelvic brim.

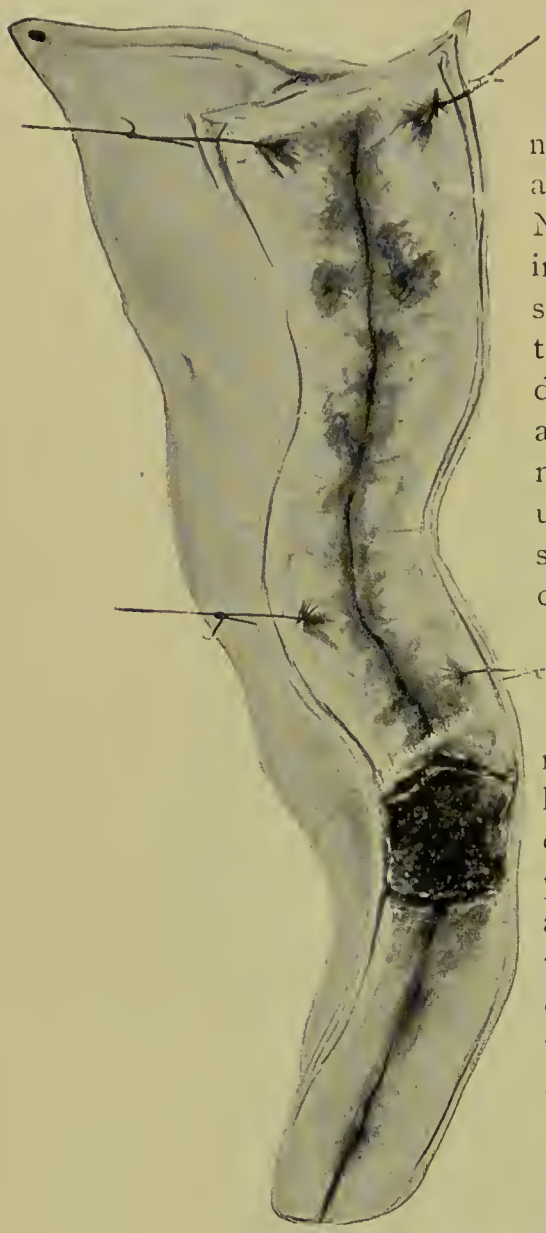

Fig. 15.—Single round slough.

The nerves of the appendix are acutely inflamed in progressing infection, but the most interesting nerve complications occur after the attack of appendicitis has subsided. Nerve filaments caught in contracting scar tissue are the source of persistent discomfort for the patient, but the principal symptoms appear to be due to chronic sclerosis following acute neuritis. The interstitial connective-tissue elements of the nerves undergo marked hypertrophy. In some cases in which the appendix has disappeared with the exception of a fibrous string of connective tissue, ill-defined muscularis and peritoneum, the sclerosed nerves yet keep the patient more or less of an invalid, because they exert an influence which inhibits the peristaltic movements of the colon, and predisposes to constipation, intestinal fermentation, and general dyspeptic symptoms. I supposed that this influence was due to old adhesions until I found that patients in whom few adhesions existed were relieved from their discomfort and rapidly gained in health and strength after the removal of sclerosed appendix remains.

Peritonitis is the most important complication of appendicitis, and one which formerly attracted our attention so closely that the appendix was often overlooked. The simplest form of peritonitis complicating appendicitis is limited to the peritoneum of the appendix and mesappendix. The irritating products of bac-

teria at work within cause a reddening and roughening of the serosa of the appendix and mesappendix. The latter contracts firmly, remaining contracted and fixed by adhesions if the inflammatory process is severe enough to cause the formation of plastic peritoneal exudates on the layers of the mesappendix. When the leucocytes fail to limit the peritonitis to the region of the appendix, by their anti-toxine, the peritoneum over near-by structures throws out plastic exudate, and the appendix is entirely surrounded by adhesions which wall it in. This is a very pretty subterfuge on the part of Nature, and it protects the patient unless bacteria have gained too much headway. Nature is appreciative of success, however, and when the bacteria have proven themselves to be very enterprising, she transfers her interests from the patient to the fine colony of bacteria whose claims for vested interests outweigh those of the patient. In such a case the protecting peritoneal exudate is liquefied by the bacteria which escape into the general peritoneal cavity in large quantities, and which excite a diffuse peritonitis if the patient is under the influence of opium. If we help the patient, however, by passing hygroscopic salts through the alimentary tract, and allow natural events to follow, toxic fluids are drawn into the intestinal canal by osmosis, and active phagocytosis takes place so rapidly in the broad field of the peritoneum that the patient may be saved. Our intense fear of pus in the peritoneal cavity is unwarranted by present knowledge, and some pus in some peritoneal cavities is certainly harmless, if we manage the peritoneum well. Before its functions were well understood the peritoneum was often misused, and it responded in kind, so that we feared peritonitis. In our day the peritoneum has become the surgeon's best friend, and with its aid the most extensive abdominal operations are done with safety. We call it to our aid in

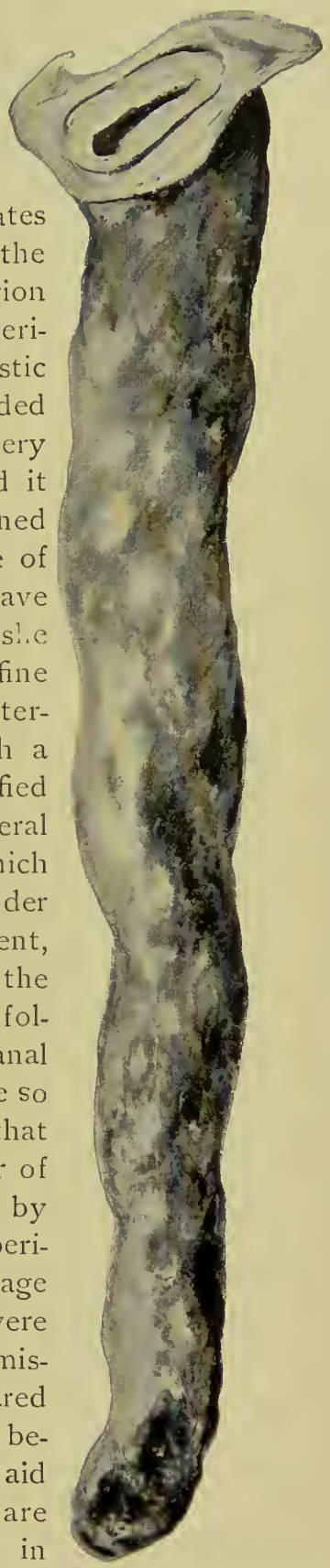

FIG. 16.—Whole appendix, gangrenous and sloughing.

walling in the buried stump after the removal of the appendix, and we direct it to dispose of bacteria and toxines. To-day, the peritoneum does yeoman service for or against the patient, according to the dictation of the surgeon. The extent of infection in a case of peritonitis with appendicitis bears no direct relation to the extent of destruction in the appendix itself. The most violent peritonitis can occur in cases in which bacteria have migrated out of the appendix by way of the blood-vessels, lymphatics or loose connective-tissue planes, not going through the walls of the appendix. On the other hand, a very little local peritonitis may suffice to wall in a perforated or completely

FIG. 17.—Gangrene of mesappendix.
A. Appendix not yet dead.
B. Mesappendix.

sloughing appendix. We therefore over-estimated the relative importance of perforation of the appendix formerly. The fallacy has gone abroad that the appendix is usually destroyed in cases in which abscesses have formed. We opened such abscesses without doing anything further in former years, before the principles involved were clearly in mind, and have subsequently removed from these patients appendices which had suffered comparatively little damage. There are certain cases in which it is wise to leave an infected appendix at the bottom of an abscess cavity, but such appendices cannot be left on the theory that they will give no

further trouble after the patient has recovered. In one of my cases, in which a flood of intra-peritoneal pus was discharged by way of the mouth and vagina simultaneously, entering the mouth after perforation of the lung, the patient had subsequent attacks of appendicitis, and the appendix on being finally removed was found to present simply two scar-strictures and a honeycombed lymphoid coat, the outer tube of the appendix being unperforated.

When bacteria have liquefied the peritoneal plastic exudate about a walled-in appendix, the peritoneum usually protects by putting up new plastic walls farther and farther away, so that enormous walled-in abscesses frequently result. Very often

FIG. 18.—Perforated appendix.

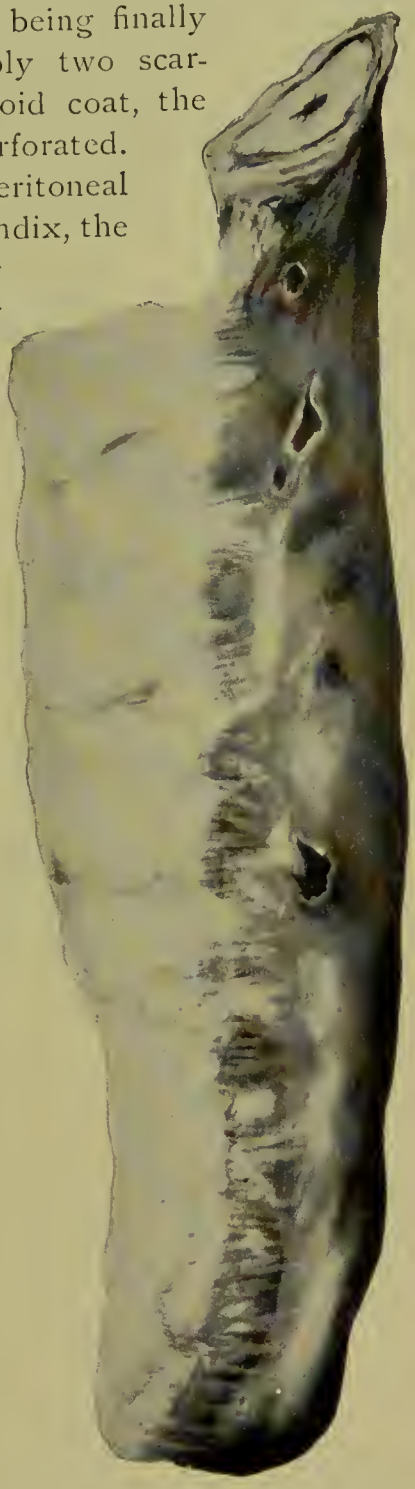

FIG. 19.—Multiple perforations of appendix.

the plastic exudate becomes liquefied by bacteria at several points, leaving firm exudate in the intervals, and we then have multiple abscesses. That fact forms the rational basis for the procedure of separating all adhesions in some operations upon acute appendicitis cases with pus. If we evacuate one large abscess, a very small undiscovered abscess may prove fatal to the patient. Intra-peritoneal abscess cavities sometimes fail to evacuate their contents spontaneously, or to prove fatal to the patient, and such collections of fluid may remain encapsulated for many years, making the patient an invalid, and subjecting him to the distress of acute exacerbations of inflammation from time to time. If in such encapsulated collections the bacteria kill themselves and their spores with toxines, the sterile fluid and contained debris may undergo absorption. Abscess fluids, whether formed within the peritoneal cavity or in the sub-peritoneal connective tissues, if neglected by the surgeon, may open externally upon the abdomen, or they may perforate the ureter, the bladder, the bowel, the iliac vessels, or even the pleura and lung. An appendicitis patient with an abscess cavity that is seeking a point for evacuation of its contents, is consequently in a most critically dangerous position. A large, intra-peritoneal abscess may form with com-

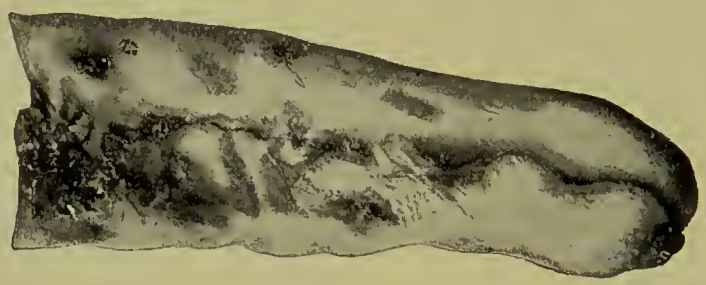

FIG. 20.—Appendix kept partially alive by adhesion circulation after destruction of its artery.

paratively little pain, but intense suffering results from abscess formation about the iliac arteries, because the strong pulse gives an increasing succession of blows to the sensitive structures that are bound to the spot by plastic exudate.

When an abscess forms about the large nerves of the pelvis, a distressing neuralgia complicates the case. Adhesion bands are extremely common after recovery from acute appendicitis. The plastic exudate which is thrown out for the protection of the patient may undergo nearly complete absorption if the case is one of short duration, and in other cases short, firm adhesions

remain permanently, but cause little trouble. In a less fortunate group of cases, the adhesions are pulled out into long bands by

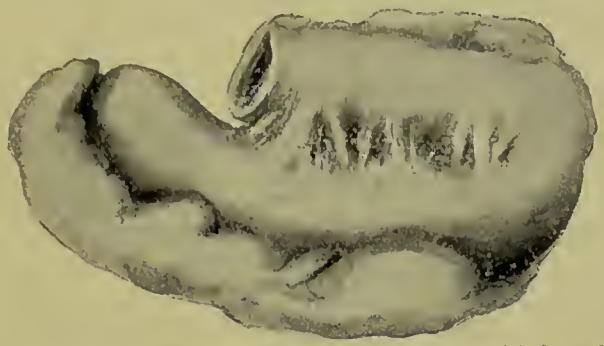

FIG. 21.—Interval case. Circulation interfered with by adhesions.

the action of the moving viscera. A complication similar to adhesion bands is caused by the omentum, which is very commonly caught in adhesions at that part of its border which

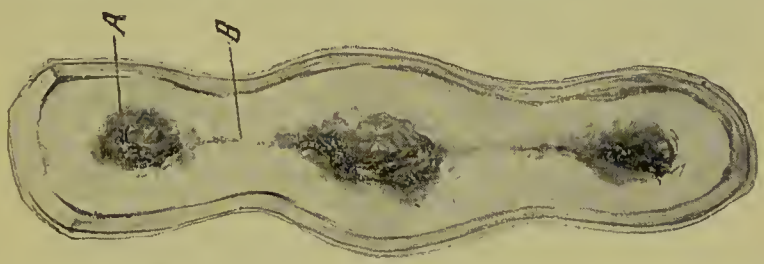

FIG. 22.—Interval case. Three pus cavities formed by scar strictures.
A. Pus cavity.
B. Scar strictures occluding lumen of appendix.

touches the appendix. The movements of the viscera then roll the free mass of omentum up into a rope, or divide it into filaments, which, fixed above and below, set a trap for loops of bowel. Adhesion bands cause volvulus and kinking of the bowel. They mechanically inhibit peristalsis of the colon, and strangulation of the bowel occurs in such adhesion bands years after an attack of appendicitis has been forgotten, if it was ever recognized. The most frequent complications caused by intra-peritoneal adhesion bands are not the dangerous ones, but consist simply in chronic constipation from mechanical inhibition of peristalsis, or in occasional attacks of distress from temporary incarceration of knuckles of bowel. A phlebitis of the iliac and femoral veins is a common complication of infective appendicitis, and may cause death in a case which is otherwise a moderate one. Acute suppurative nephritis may suddenly appear in a very sim-

ple case of appendicitis by infection travelling up the ureter. I lost one such patient, a student who came into the office smiling, with his books under his arm, and saying that his physician thought he had appendicitis, and wished to have me see the case. I found an appendix somewhat tender and firm with interstitial exudate, but the patient had no constitutional symptoms of infection. I asked him to enter the hospital the next day and have the appendix out. When I saw the patient on the following day, he was in a hopeless condition from acute suppurative nephritis, which proved fatal.

FIG. 23.—Post-appendicitis adhesion band from cecum snaring a loop of ileum.

Septic pleuritis and pneumonitis suddenly and unexpectedly develop in any stage of progress of infective appendicitis. Tuberculosis and neomata of the appendix are not often complicated by infective appendicitis, because the progress of these diseases is slow, and the structures of the appendix have ample time to ad-

just themselves to the new conditions, just as they do in hydrappendix where slowly accumulated mucus, dammed by a stricture and sterile from suicide of its bacteria, gradually forces the lymphatics and blood-vessels to become hypertrophic in a compensatory way. Such compensatory hypertrophy and multiplication of structures is impossible under ordinary conditions of acute infection. Catarrhal appendicitis has not been observed by me as yet, because I differentiate infective appendicitis from catarrhal colitis with involvement of the appendix, and do not operate in the latter cases, nor do I call them cases of appendicitis. When I operate it is upon cases of infective appendicitis in various stages of progress, and the responsibility that goes with the making of a diagnosis is such that I believe it to be morally wrong for us to make the diagnosis of catarrhal appendicitis at the bedside before the specimen has been seen. The simplest stage of infective appendicitis, and one which is perhaps most often wrongly called catarrhal appendicitis, causes symptoms when exudate-compression-anemia and toxic destruction of cells cause a small portion of the inner tube of the appendix to disappear by ulceration, or by sloughing, before the resistance factors are in control of the tissues. When infection halts, the gap left in the tissues of the inner tube is closed by granulation, and eventually by connective tissue, which slowly contracts and narrows or closes the lumen of the appendix. In such a case the patient may be free from symptoms of appendicitis in two or three days, but the progress of mild infective appendicitis is often protracted, and marked by slow erosion of mucosa and lymphoid tissue, caused by pressure of interstitial exudates; by muscular spasm of the outer tube, by obliterating hyperplasia of the tunica intima of small arterial branches, by plugging of lymph channels, or by direct toxic destruction of cells. Connective tissue gradually replaces the broken-down inner tube, and if it is evenly replaced without the formation of stricture nodes, the disease may eventually disappear without causing disaster or even very marked symptoms. In these chronic cases of infective appendicitis, all structures excepting the mucosa frequently become excessively hypertrophic during the period of infection, but finally nothing remains excepting a string of connective tissue surrounded by ill-defined remains of muscle and peritoneum, and containing sclerotic nerves. We cannot reasonably expect that any particular case of appendicitis will end in this way, because the accidents of acute exacerbations of the infection too often bring the case

to a more abrupt termination. In the more vicious forms of acute infective appendicitis, all structures of the appendix are partly or wholly destroyed quickly. If the appendix is well walled in with plastic lymph, the sloughs which form are decomposed by saprophytes, and the stump of the appendix or the opening in the cecum gradually heals. Rhexis of the appendix, a condition in

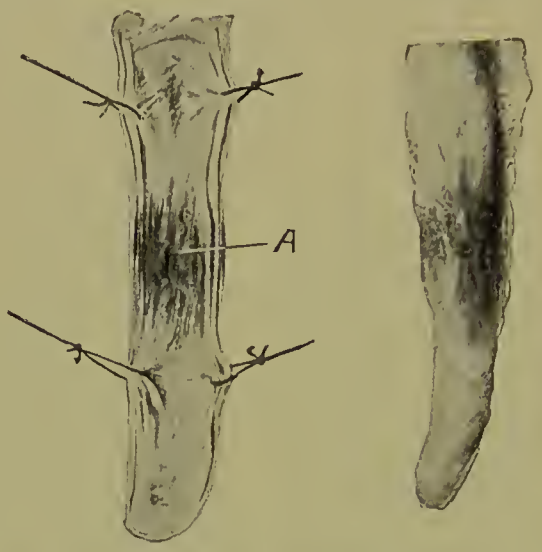

FIG. 24.—Rhexis of middle segment of appendix—A.

which the capillary vessels allow their contents to escape interstitially into all the structures of the appendix, dissecting tissues apart, and distending structures with blood, indicates a savage type of infection, but one which occasionally fails to give symptoms of importance until the condition of gangrene supervenes.

Appendicitis occurs principally in young males. The fact that women do not suffer from this disease so often as men has been well established by post-mortem examination statistics, and is not based on the theory that in women diseases of the ovaries and oviducts are more often mistaken for appendicitis, because such mistakes in diagnosis are easily avoided. There are three fairly good reasons why women suffer less often from appendicitis, viz.: (1) There is sometimes collateral circulation by way of the appendiculo-ovarian ligament; (2) women expose themselves less to the production of traumatic infection atria; and (3) the flaring pelvis in women is not so likely to hold a displaced appendix in a cramped position. About twenty per cent. of the cases of appendicitis occur in women. It is most common in both sexes between the ages of ten and thirty-five. But it may occur

in the infant at the breast, or in the old man in his dotage. The very young, and those past middle life, expose themselves less often to the production of traumatic infection atria. Another reason why the disease occurs more rarely after middle age is because the appendix undergoes a certain involution process, which sometimes leaves it bare of mucosa and lymphoid tissue in old age.

A nomenclature has been sought for the description of various kinds of appendicitis, but apparently there is only one kind of appendicitis which produces acute symptoms,—infective, exudative appendicitis,—caused by bacterial invasion of a structure which is peculiarly unfitted to resist the effects of such an invasion. The various phenomena of infective appendicitis should not be described as indicating different kinds of appendicitis, but rather as marking different forms of one kind of disease. Thus we may speak of the acute or chronic form, the form of endo-appendicitis, or of perforation, or of hydrappendix, and so on indefinitely; but as endo-appendicitis may be present on Monday and perforating appendicitis may appear on Wednesday in the same case without our being able to state what Friday appendicitis may be like, we might classify these cases as "Monday," "Wednesday," and "Friday" appendicitis. The diagnosis in each case would be made afterward. We cannot know that any attack of infective appendicitis will stop at any one form short of complete destruction, because the power of the principal resistance factor in any one case is absolutely unknown. By "resistance factor" I mean so-called phagocytosis. We can place a case in a certain sort of classification after we have seen the specimen, but such a post-diagnosis is not more fair than a game of whist after an opponent's hand has been seen. If we classify cases as fulminating cases, or as cases with abscess, we are classifying them from the symptoms of complications without reference to the actual condition of the appendix, or the form of the appendicitis proper.

There are no groups of symptoms which will allow us to make a rational prognosis as to the eventual outcome, or the prospective complications in any progressing case of appendicitis, and we must abandon the hope of having any such classification of symptoms for a guide in the future. Attempts will be made from time to time to classify symptoms for prognosis from small groups of cases, but they will fail because of the nature of the disease.

I speak, then, unequivocally, knowing that some patients are to die and others are to suffer unnecessarily because their advisers will believe themselves to be upon a prognostic track. There is but one rule to be followed, and that is to isolate an infected appendix as promptly as we would isolate a case of diphtheria and for practically the same reasons, viz.: the infected appendix will probably infect other structures, and the infected throat is likely to infect other throats. An infected appendix is isolated when it is out of the patient. All cases of appendicitis that are otherwise within surgical limitations, and that are within reach of competent surgical services, are cases for prompt isolation of the appendix. Various periods of waiting have been tried with the effect of proving that the question is wedge-shaped, with the greatest number of deaths at the broad waiting end, and the smallest number of deaths at the point of isolating an infected appendix while infection is limited to the confines of the appendix. We are held to our rule by two cardinal principles, viz.: (1) Every hour of progress of any acute attack of appendicitis means increased damage to viscera; and (2) with no infected appendix the patient would have no complications of appendicitis, and therefore the patient would have no complications of appendicitis if we leave him with no infected appendix. It then becomes a matter of interest to note the comparison between the death-rate of medical and surgical treatment of appendicitis. Statistics from a large number of observers give an average death-rate in the principal attack of appendicitis of about fifteen per cent. under medical treatment, and I assume from experience, without being able to obtain available data for reference, that nearly ten per cent. more die from the numerous chronic complications resulting from previous acute attacks. According to Bull's statistics, from a large number of selected operators, the surgical death-rate of appendicitis is not far from two per cent. in cases operated upon at a time when infection is limited to the confines of the appendix. Bull's statistics, however, include only "interval cases"—cases which were already of the complicated class. I believe that a surgical death-rate of two per cent. is illegitimate in cases operated upon in the first attack before infection has extended beyond the confines of the appendix. If the surgical death-rate were fourteen per cent. and the medical death-rate fifteen per cent. our duty would still be clear. We have learned that the peritoneum is not to be feared by the surgeon in such cases, and now

that we know the possible dangers of ligating the appendix like an artery, there are no further dangers in sight excepting from an imperfect aseptic technique, a responsibility which rests with the individual surgeon, and from ordinary causes which have no direct connection with the appendicitis. From experience I judge that we must place the surgical standard at less than one per cent. mortality rate in cases of appendicitis operated upon by skilled operators at the proper time for removal of infected appendices.

The surgical treatment of appendicitis has made three distinct steps in progress within the past decade. Ten years ago we simply opened the abscesses of appendicitis when they were strongly in evidence. The first planned operations for the removal of infected appendices were done about the time when Dr. Fitz, of Boston, gave a great impetus to the investigation of the subject in his classical paper in the *American Journal of the Medical Sciences* in 1886. Intense interest in the subject was soon aroused, and surgeons generally began to search for infected appendices, but at such a late stage in the progress of the disease that statistics at first showed little if any advantage in favor of surgical treatment. The reason for that was because infection at the time chosen for operation was beyond the reach of resources of the surgery of that day. Then came the period of operating in the interval between attacks, or in the early stages of the first attack, and statistics at once showed the very great advantages of this treatment.

There remained then only the necessity for perfecting the operation in such a way as to avoid the occurrence of post-operative ventral hernias and of unsightly scars, and this has now been done. Medical treatment, which cannot reach the bacteria that are invading the tissues in the appendix, will nevertheless give very decided comfort in many cases in which surgical services are not obtainable. Opium will cover up distressing symptoms, and allay the feeling of unrest which is very marked in appendicitis. Hot fomentations over the inguinal region will relax the exhausting spasm of the abdominal muscles, and may sometimes relax the outer tube of the appendix temporarily, but the tonic spasm of the muscular tube of the appendix is caused by direct toxic irritation, whereas the tonic spasm of the abdominal muscles is sympathetic, and due to a reflex from the appendix region. The orthopedists are the only members of our profession who, as a

class, are able to appreciate the exhausting effect and the disastrous influence of long-continued muscular spasm. When hot fomentations fail to relax the muscles of the anterior walls of the abdomen completely, we may be quite sure that muscular spasm of the outer tube of the appendix is persisting down below, unless that outer tube is destroyed or paralyzed by interstitial exudates. Olive oil or saline cathartics passed through the alimentary tract will remove fermenting intestinal contents, and decidedly lessen the so-called auto-intoxication which is an element of much importance in these cases. Personally, I should prefer the saline cathartics for the purpose, but the Homeopathists have used olive oil with success for a great many years, and we may rest assured that its popularity with them is based upon observations of its usefulness. By usefulness I mean the obtaining of comfort for the patient. His chances for recovery are not much improved by any treatment which fails to remove the nest of infection, and that nest is out of the road of medical resources in appendicitis. So many patients will recover from one or more attacks without any treatment of any sort that we are apt to be misled as to the value of medical treatment excepting as to the comfort which it gives a distressed patient.

Appendicitis patients who are in a position to receive surgical treatment should have very little preparatory medical treatment. Opium is to be particularly avoided, especially if the case is complicated by peritonitis. We need to have the peritoneum active if it is to serve the surgeon well. With an active peritoneum we may open the abdomen and remove the tubular tonsil almost as safely as we open the mouth and remove the flat tonsil, provided that the operator is expert.

Our recognition of the safety of such work under the principles of new surgery would tempt us to remove the normal appendix when it appears in the field of our other abdominal work. To this I am opposed on the principle that the death-rate of no surgical operation can be reduced absolutely to zero, and the surgeon who would protect his patient must not remove an appendix until there is infection, and consequent occasion for removing it. I refuse to remove uninfected appendices, and can find at the same time no rational excuse for failing to promptly remove infected appendices. The cause of prompt operative treatment for appendicitis has had to labor against the prejudice aroused by unnecessary ovarian surgery, just as diphtheria anti-toxine to-day

has to labor against the reaction which followed the trial of Koch's lymph. The operative treatment of inflamed ovaries and tubes had a pendulum movement—too many operations were done because the reasons for operating were not always founded on a sufficiently rational basis. Then came a reaction, and to-day, not enough operations are done in some localities. Eventually the equilibrium will be found. The treatment of infected appendices has never had any pendulum simile, but rather the simile of a door which has gradually closed upon the question of immediate operation, leaving it no longer an open one. An inflamed ovary seldom threatens life unless it is the seat of a dangerous neoma or abscess; it usually responds to palliative treatment, and may be a very useful organ. An appendix, on the other hand, is never a useful organ, and it always threatens life when infected. I frequently spend half an hour in the attempt to save a damaged ovary, separating adhesions, freeing agglutinated fimbriæ, and opening a closed oviduct, instead of removing the mass, which at first looks so unpromising. With the damaged appendix I spend only time enough for its removal. Sometimes when engaged in other abdominal work I find phosphatic or fecal concretions in appendices, and liberate them by pushing them through into the cecum, not disturbing the appendix if it shows no evidence of infection. In some cases so-called ovarian neuralgia could have been relieved if the surgeon, on finding a normal ovary, had turned to the appendix and liberated a concretion. It is rather unsafe to leave an appendix which has contained a concretion, unless the surgeon is familiar with the appearance of normal appendices, and it is only within the past year that I have dared to do it. There is one position in which the surgeon may hesitate about operating when he finds a far advanced case of appendicitis at his first visit, and that is in a town where the people are not likely to distinguish between the *post hoc* and the *propter hoc*, if the patient dies after the operation, and not because of the operation. The surgeon knows if he waits for the bacteria to kill themselves by their toxines, or to be killed by the anti-toxines, he can remove the appendix with safety as an "interval case." He also knows that the patient may die before the bacteria cease work in that particular case. If he operates, and the patient dies because bacteria were in advance of surgical resources, all operating for appendicitis may be stopped in that town, and lives may be lost, and much unnecessary suffering will ensue because the people will

fail to avail themselves of proper resources at a proper time. Consequently, as a matter of policy, the surgeon may find it right to adapt himself to his surroundings, and to sacrifice the individual patient by refusing to give him help,—in the interest of the public. More lives will really be saved in such a town if in such a case we refuse to give a father a chance to live for his family, or refuse to try to help a son who is the sole support of aged parents. This picture is by no means a fanciful one, as we all know very well. Personally, I have never been able to refuse to help the individual, and other patients have been lost from neglect because a far advanced case of appendicitis died in spite of all the resources which could be applied. No such opprobrium follows the death of an appendicitis patient under medical treatment. The progress which has been made in the treatment of appendicitis has been based on accurate information relating to the problems that are involved, just as we have made recent progress in many other lines. Not many years ago, when a woman came into the office complaining of sick-headache, or nervous dyspepsia, we thought first of medical treatment, and such medical treatment was usually unsatisfactory because we obtained temporary relief only from the treatment of symptoms. To-day, in making a diagnosis by exclusion in such a case, we are called upon to eliminate the possibilities of irritation from errors of refraction or inflamed rectal papillæ, or a uterus out of position, or septic oviducts, or a loose kidney, or carious teeth, or hypertrophies of the turbinated bones; and the proportion of such cases that are found to be essentially surgical is very large. The insane asylums are now robbed of many of their victims by our present knowledge of the accurate methods of giving relief—a knowledge which makes it easy for the patient and difficult for the physician, in contra-distinction to the not very old plan which was easy for the physician, and hard for the patient. Our advances in the field of appendicitis, however, now make treatment easy for both physician and patient. Ten years ago most of our appendicitis cases were treated under the aliases of acute indigestion, bilious colic, malarial fever, la grippe, peritonitis, entero-colitis, cecitis, neuralgia of the bowel, intussusception, volvulus, intestinal obstruction, typhlitis, perityphlitis, typhoid fever, salpingitis, ovaritis, gall-stones or gravel; while some of the abscess complications caused the cases to be classed as psoas abscess, coxitis, abscess of the abdominal

wall, peri-hepatitis or peri-nephritis. Appendicitis is of such common occurrence that we have all lost friends and acquaintances from that disease, and such multitudinous forms of abdominal disease are simulated by appendicitis that we must press with our fingers at "McBurney's point" in almost any case of acute abdominal inflammation of sudden onset as regularly as we would look at the tongue. I have seen appendicitis overlooked on post-mortem examination in former years, because the appendix happened to be buried in adhesions, and because it was only a little thing anyway!

The symptoms of appendicitis do not indicate the condition of the appendix more closely than they do the condition of the infected wisdom tooth in which a very small carious point of infection may excite an intolerable neuralgia, or it may be the cause of suppurative alveolar disease, pyemia, septic meningitis or abscess of the neck. Another wisdom tooth may become entirely carious without giving any symptoms beyond an occasional toothache. We may find a completely gangrenous appendix in a case in which the patient is resting quietly in bed with normal temperature, pulse, and respiration. The reason why the appendix is free from tenderness is because it is dead, nerves and all. The temperature and pulse are normal because toxines are not escaping into the general circulation. The face of such a patient, however, usually looks "wrong" to the members of his family. In another case with trifling ulceration of a part of the inner tube of the appendix we may find the patient throwing himself out of bed on the floor, rolling in agony, and striking himself upon the head with any near object in an insanity of pain from irregular spasm of the muscular coats of the intestine, otherwise known as colic. His temperature may be 103° F., and his pulse rapid. Such extreme cases as the above two are seen by all of us who are engaged much in abdominal work. The presence or absence of an inguinal tumor is a matter which must not be taken into consideration in estimating the value of the testimony of symptoms, because an acute general peritonitis may appear in a case of appendicitis in which the appendix is not perforated, and not surrounded by plastic lymph; and a perforated or dead appendix may be walled-in by plastic lymph which is barely sufficient to close the opening or surround the slough. In the latter case there is danger in an examination for tumor, unless the surgeon is prepared for immediate operation when he has accidentally separated the

frail adhesions in making an examination. On the other hand, a large mass of plastic exudate may form about an appendix which is whole, or perforated, or sloughing in its entirety. For these reasons the presence or absence of an inguinal tumor is not important as giving a clue to the condition of the appendix itself. The groups of symptoms which belong to the various forms or complications of appendicitis are so multitudinous as to be extremely confusing to one who attempts to study the subject from the elaborate descriptions of authors, unless he has had considerable practical experience; and yet the disease is diagnosticated as readily as a broken leg by any one who has accustomed himself to looking for it. The correctness of such diagnoses are verified by operation.

In most cases of appendicitis, the surgeon is guided well by certain symptoms which are of pretty regular occurrence, and in order to give a clear view I will adopt the plan of describing one typical case only.

TYPICAL CASE—FIRST DAY.

Subjective Symptoms.

(*a*) General abdominal pain of sudden onset.
(*b*) Waves of colic.
(*c*) Nausea and vomiting.
(*d*) Tenderness on finger-point pressure at McBurney's point.

Objective Signs on Palpation and Inspection.

(*e*) Abdominal muscles firmly contracted and resisting pressure.
(*f*) Appendix feels harder than the cecum.
(*g*) Fulgurant spasm of the external oblique muscles near their costal attachments when the region of the appendix is sharply tapped with the finger.

Testimony of Little Value.

Pulse, temperature, respiration, condition of the bowels and bladder.

Analysis of Symptoms.

General Abdominal Pain is due to the reflection of irritation along the widespread branches of the superior mesenteric plexus, suddenly appearing when toxic irritation of the muscular tube of the appendix has caused it to contract firmly upon its contents.

Colic is sympathetic spasm of the muscular coats of the bowel due to over-stimulation of Auerbach's plexus, but such spasm of the small

intestine and colon occurs at intervals, instead of persisting, as it usually does at the centre of infection in the appendix.

Nausea and Vomiting mean reversed peristalsis of the stomach, caused by toxic irritation of the sympathetic nerves at the appendix. If the vomiting is bilious in character, it shows that the duodenum is also reversed, and is filling the stomach with bile. Tenderness on finger pressure at McBurney's point is due to inflammation of various structures of the appendix lying beneath. McBurney's point is situated about two inches from the anterior superior spine of the ilium on a line drawn from that spine to the navel. The appendix sometimes occupies various positions in the abdominal cavity, but we almost invariably find at least the proximal end of the appendix at the normal site.

The tonic contraction of the muscles of the anterior abdominal wall is a reflex phenomenon, and one which we read as meaning that the inflamed appendix is to be protected against traumatism. It has the same significance in appendicitis that tonic contraction of the muscles of the thigh has in coxitis. It is interesting to note that the abdominal muscles protect an inflamed appendix regularly, but that they usually fail to take interest in an inflamed ovary and tube situated a couple of inches away and remain normally relaxed. This point is one of importance in some cases in which a diagnosis between salpingitis and inflammation of the appendix lying in the pelvis becomes difficult.

Hardness of the appendix is due to interstitial exudate, and palpation easily reveals this condition in the "interval cases" of appendicitis after the period of acute infection has passed. In the primary stage of acute infection, the firm contraction of the abdominal muscles often makes palpation of the appendix difficult unless the patient is anesthetized, and in the stage of recent perforation or gangrene of the appendix, it is dangerous to palpate. Excepting in the acute stages of inflammation, palpation of the appendix is easily done, as soon as one has taken pains to become a little expert at it. Dr. Edebohls's plan of palpating the appendix is as follows: The patient lies upon his back with the legs comfortably flexed. "The examiner standing at the patient's right begins the search for the appendix by applying two, three, or four fingers of his right hand, palmar surface downward, almost flatly upon the abdomen, at or near the umbilicus; while now he draws the examining finger over the abdomen in a straight line from the umbilicus to the anterior superior spine of the right ilium, he notes successively the character of the various structures as they come beneath and escape from the fingers passing over them. In doing this, pressure exerted must be deep enough to recognize distinctly, along the whole route traversed by the examining fingers, the resistant surface of the posterior abdominal wall and of the pelvic brim. Only in this way

can we positively feel the normal or the slightly enlarged appendix. Pressure short of this must necessarily fail."

Dr. Edebohls's method of palpating is very satisfactory, but I have lately found that for myself an easy way is to stand on the patient's right, using three right-hand fingers to feel with, and three left-hand fingers placed upon these to press with. The fingers that are to do the feeling are pressed by means of the three others down under the border of the right rectus abdominis muscle at the level of the navel, and slowly drawn toward the examiner. My sole landmark, the ascending colon, is then felt to slip out from under the fingers, and by repeating the process toward the cecum, we soon come to the end of the cecum, and there begin to hunt for the appendix by rolling the cecum to one side or the other of the finger tips. The proximal end of the appendix is found near the distal extremity of the cecum, and we then follow the rest of the appendix in any direction. The proportion of appendices that cannot be palpated will become smaller and smaller as the finger tips become educated. The point about using no muscular effort in the hand that is to be used for feeling is as important in palpating appendices as it is in palpating ovaries and tubes. The very delicate sense of touch is preserved if the left hand is used for pushing upon the examining hand. The only structures that need to be differentiated from the appendix in palpating are, the iliac artery, the epiploic appendages, and subperitoneal lymph glands. Pulsation distinguishes the iliac artery ; an epiploic appendage is usually much shorter than the cecal appendage, but it is often necessary to roll an epiploic appendage about under the fingers several times in succession in order to accurately get its proportions. Subperitoneal lymph glands feel precisely like the tip of a normal appendix when they are swollen, but they are not freely movable, and are short.

Fulgurant spasm of the external oblique muscles I so name because of the quick tremulous flashes of contraction which are easily observed near the costal attachments of these muscles when the region over the appendix is tapped quickly with the finger if a patient is not too fleshy. It is a reflex spasm which indicates extraordinary attempts at protection of the abdominal contents by a set of muscles which are already protecting up to a last degree consistent with the retention of their power.

The reason why the pulse, temperature, and respiration give no testimony of particular value at the outset of the attack of appendicitis is because different patients respond so differently to the first impress of toxines on the great sympathetic nervous system, and because in appendicitis the character of the toxines changes rapidly as different bacteria become ascendant. The effect is as varying in character as is the

effect of the toxine of saccharomyces (alcohol) upon the same patient if used in different media such as champagne, beer, and absinthe.

Constipation and diarrhea are of little value as first signs, because toxines may inhibit peristalsis and may stop the production of mucus by paralyzing portions of Meissner's plexus. If the infected appendix lies near to the hypogastric sympathetic plexus and excites its branches, the patient may be compelled to empty his bladder every half hour ; if the sacral plexus is first involved, the patient may have spastic dysuria ; if neither plexus is disturbed, the bladder will not be disturbed, and consequently the character of the disturbance of the bladder is of little consequence except as showing where some part of the appendix probably lies.

TYPICAL CASE—THIRD DAY.

Subjective Symptoms.

(*a*) Pain, localized in the right inguinal region.
(*b*) Anorexia.
(*c*) Tenderness on pressure anywhere in the right inguinal region.
(*d*) Constipation.

Objective Signs.

(*e*) Face anxious.
(*g*) Abdominal muscles contracted and resisting.
(*h*) Peritoneal lymph adhesions obscure the outlines of the appendix on palpation.

Symptoms of little value are given by the temperature and pulse. *Pain is localized in the right inguinal region*, because reflex pains in other parts of the abdominal cavity are not likely to continue for more than one or two days in appendicitis. *Tenderness on pressure* anywhere in the right inguinal region is due to inflammation of structures round the appendix. *Constipation* is probably symptomatic of Nature's attempt to keep the vicinity of the appendix undisturbed, and adhesions of the cecum aid very materially in inhibiting the peristalsis at that point. So marked is the constipation in many cases that it amounts practically to bowel obstruction. *The patient's face is anxious*, presumably because of toxic paralysis of motor nerves supplying muscles of the face. A much more destructive process two inches from the appendix, in an ovary in which other species of bacteria are at work, will not often give this face. *Respiration is short* because the patient dreads to take a full breath which would cause pressure on a sensitve abdomen, and it is increased in frequency in order that the full function of the lungs will continue in spite of the limitation of working surface, by short inspiratory efforts. *The tonic spasm of the muscles* of the abdominal wall continues to guard the contents within, but a certain

degree of exhaustion of the muscles is indicated by less responsive fulgurant spasm when the region over the appendix is tapped with the finger. This plainly tells also of the exhausting effect upon the patient of continued over-use of one set of muscles—a strain which a strong man who is not being undermined by bacteria could not well afford to bear. He cannot hold an ounce weight in the extended hand for five minutes, yet he must suffer contraction of the abdominal muscles, perhaps for days. *Peritoneal lymph* coagulates about the infected appendix for the purpose of walling it in so well that the bacteria will be confined to a restricted field, and the subterfuge is successful unless bacteria have gained such headway that they attack and destroy this wall. The pulse and temperature are still unimportant as indicating the actual character or extent of the destructive process.

Toxines from streptococci may excite the sympathetic nerves which control the muscles of the arteries and heart, and stimulate them until the pulse is full and bounding, and the streptococci may cause increased liberation of animal force in the form of heat, so that the temperature is high ; or a more destructive process may be taking place under the influence of colon bacilli, the toxines of which are not liberating energy in the form of heat, but which are over-stimulating the sympathetic nerves until the heart cannot relax well before each contraction, and we have the rapid, feeble pulse. I dread a normal temperature in appendicitis more than a high temperature, because the colon bacilli infect so insidiously. As a general statement, however, it is best to say that the temperature of the patient must be entirely left out of our calculation in forming an estimate as to the condition of a case of appendicitis.

TYPICAL CASE—TENTH DAY.

(*a*) Vital signs nearly or quite normal.
(*b*) Appetite returning.
(*c*) Bowels moving irregularly.
(*d*) Little exudate to be felt about the appendix.
(*e*) Abdominal walls relaxed.

TYPICAL CASE—TWENTIETH DAY.

(*a*) Occupation resumed.
(*b*) Tendency to constipation.
(*c*) Cautious about diet.
(*d*) A little tenderness to be elicited on palpation of the appendix.

The patient is inclined to be constipated because sclerosis of the nerves of the appendix following inflammatory neuritis disturbs the branches of Auerbach's plexus, or because unabsorbed lymph adhesions inhibit peristalsis, beginning at the cecum. Dyspeptic symptoms appear

unless the patient is careful about his diet, because the disturbance of the branches of the superior mesenteric plexus, though slight in character, is quite constant in effect, and intestinal fermentation is consequent upon incomplete digestion. Added to the influence of sclerosis of the nerves and of adhesions which put a hand on the bowel, there is a constant and mild septic impression from toxines absorbed through the bared lymphoid coat of the appendix from bacteria which are living in its lumen.

TYPICAL CASE—TWO HUNDREDTH DAY.

Patient feels and looks well, but is apt to use tonics to overcome the influence of constant slight toxine absorption. He feels the need of an occasional purgative, and from time to time there is a little sensation of discomfort in the right inguinal region, from involved nerve filaments, from adhesions, or from the tense appendix. The more he feels this sensation, the more frequently he tells his physician and friends that he is perfectly well, hoping to thus deceive himself, if he knows that his acute attack was from appendicitis. If he is unaware of that fact, he forgets all about his acute attack when describing symptoms of dyspepsia and constipation, for which he goes to his physician for relief.

TYPICAL CASE—FOUR HUNDREDTH DAY.

Second acute attack—bacteria lurking in the lumen of the appendix again excite an increase of interstitial exudation, and having handicapped the resistance factors are making incursions into the tissues of the appendix with great rapidity.

Such a history is characteristic of a case of appendicitis under medical treatment. Under surgical treatment the history is as follows :

TYPICAL CASE—FIRST DAY.

(*a*) Symptoms of appendicitis sufficient for a diagnosis.

(*b*) Appendix removed through an inch-and-a-half incision with employment of a technique which buries the stump of the appendix, and closes the divided layers of the abdominal wall accurately.

SECOND DAY.

(*a*) Nausea and discomfort from the effects of the ether.

(*b*) Troublesome colic from irritation of the branches of Auerbach's plexus by the operation.

(*c*) Formation of gas in the bowel from failure of disturbed sympathetic nerves to carry on assimilation of the bowel contents. Hot peppermint water the only diet.

THIRD DAY.

Perfectly comfortable when lying quietly; reads his morning paper in bed; general diet allowed.

EIGHTH DAY.

Gets out of bed; feels some general discomfort in the right inguinal region; sits in a chair for an hour, and returns to bed, but does not take a recumbent position.

NINTH DAY.

Walks about the room; little discomfort.

ELEVENTH DAY.

Assumes his occupation, and is free from lingering disturbance, and from all danger of complications, and the recurrence of appendicitis. Of lesser moment is the fact that he has saved time, and has avoided several days of unnecessary discomfort.

CHAPTER IV.

SURGICAL TREATMENT OF APPENDICITIS.

FIVE years ago a small proportion of appendicitis patients were operated upon before they had reached the life-or-death stage of septic intoxication. With other surgeons I have tried to do my part in taking appendicitis cases out of the life-or-death class and placing the operation where it belongs—in the field of preventive medicine—not preventive in the sense of removal of the normal appendix for the purpose of avoiding the occurrence of appendicitis, but rather in the meaning of isolation of an infected appendix before it has infected other structures. After surgeons had placed the operation where it belonged, medical practitioners still asked their patients to delay operation, and endure suffering and loss of time, besides risking an addition to dark statistics. Evidently there were most excellent reasons why a class of men who habitually and by training guard the best interests of the patient, should take this stand, and an analysis of their position seemed to reveal these several elements, viz.: (1) Any given attack of appendicitis was likely to run a mild course, although this could not be foretold from the symptoms; (2) occasionally an appendicitis patient for whom a simple operation had been performed, at a favorable time, suddenly developed alarming symptoms, and died; (3) after the performance of surgical operations upon appendicitis patients, who made good recoveries, ventral hernias began to appear in too large a proportion of the cases some months after the patients believed themselves to be free from all complications; (4) unsightly scars were depressing in their influence on patients who possessed a natural vanity as to their physical perfection; (5) the patient might be obliged to waste valuable time in bed.

It remained, then, for surgeons to perfect a technique which would eliminate the objections to prompt operation for isolation of the infected appendix, and such objections have been finally removed.

(1) The best surgical operations for prompt removal of an infected appendix are now less to be dreaded than a mild attack of appendicitis.

(2) Post-mortem examination in certain patients who died after operation at a favorable time, showed secondary perforation of the stump of the appendix under the ligature. The stump of the appendix could not be tied like an artery and left without further protection, because the appendix is like the colon in structure, and it is not safe in making lateral anastomosis after resection of a colon to leave the free ends simply occluded with ligatures. In an artery we have an aseptic fluid in the lumen at the point of ligature, and repair goes on in spite of compression-anemia under the ligature. In the lumen of the stump of the appendix we have fluid laden with bacteria, which are quick to attack the ring of tissue disabled by compression-anemia under the ligature. In an artery, the opposed surfaces of the tunica intima become adherent; in an appendix, opposed surfaces of mucosa or of bared lymphoid tissue do not become adherent. The stump of the removed appendix then was to be treated like the free end of a resected colon by burying the stump beneath approximated peritoneal surfaces which would effectually seal-in the weak spot in a few hours. Where that could not be done the stump was to be held up to the abdominal incision by sutures in the cecum, so that when secondary perforation occurred, bowel contents would have a short route for external escape. Thus was eliminated one objection to operation.

(3) Ventral hernias following appendix operations in which the wounds were entirely closed, were due to one potent mechanical factor—the gradual drawing apart of the margins of the incisions in the transversalis and internal oblique muscles. The margins of the incision were drawn widely apart in the normal lines of traction of these muscles at an angle to the common line of incision; for while the surgeon is at work the margins of transversalis and internal oblique muscles contract so far away from the wound that they are apt to be imperfectly united at final suturing. The line of incision could not be changed to meet this danger because that would necessitate transverse section of the external oblique aponeurosis—a structure equally important. The danger of ventral hernia in closed wounds after an appendix operation is now obviated by adopting a plan which gives a complete control of the elusive margins of deeply situated muscles—I refer to the use of the "guy-line," which will be described later.

(4) Unsightly scars often remained after operation, because of tradition from the days of life-or-death surgery; it seemed unnecessary to devote time to a neat technique which would do away with scar marring in cases where the surgeon was exultant over his success of saving the life of the patient. Now-a-days, when we state that a certain operation belongs to the field of preventive medicine, the idea includes a responsibility on the part of the surgeon to leave the patient in as good condition as he found him; consequently a very important part of the work consists in a pretty technique for cosmetic effect.

(5) Patients were usually obliged to spend three or more weeks in bed when we made long incisions for the removal of infected appendices, even in cases in which the wounds could be entirely closed by suture. The time required for repair of the wound means primarily the time required for replacement of plastic reparative lymph by normal cells. In a wound one quarter of an inch long, connective-tissue cell replacement begins in a few hours, if bacteria are not feeding upon the lymph. In a wound one foot long, in which bacteria are not feeding upon the reparative lymph, repair is delayed because of the extensive injury to trophic nerves, and the newly repaired structures will stretch apart if much pressure is brought to bear upon them, long after a small repaired place would resist pressure; consequently, a wound through the abdominal wall one quarter of an inch long would not keep the patient in bed more than three days, while a wound one foot long ought to keep him in a recumbent position for three weeks at least.

With this comparison in mind, I sought to take the mean position by making as short an incision as possible in the abdominal wall when operating for the removal of infected appendices, and I found after a few trials that an incision one and a half inches in length, through all structures of the abdominal wall, regularly gave all of the room that was required for the surgeon's fingers and for instruments, without much reference to the size of the patient or to the extent of the adhesions. Exceptional cases are at once quoted by surgeons who ask the questions which I asked myself when first trying the short incision, and which was settled by practical experience, showing that for every-day work the inch-and-a-half incision is sufficient. This incision was originally intended for cases of acute infective appendicitis at the outset of an attack, before the formation of extensive adhesions, but it was soon found that it sufficed for almost all of my "interval cases,"

no matter how extensive or how dense the adhesions. The tactile sense was to be trusted more than the eye. The only important structures which can be ordinarily injured in the separation of dense adhesions about the appendix are the ureter, bowel, and iliac vein. We know how to repair an injured ureter by Van Hook's method, drawing the proximal end of the ureter into a slit in the distal end, and suturing it there. It is not difficult to apply the Lembert suture or the Murphy button to injured bowel, and a rent in the iliac vein can be repaired by suturing. I have not injured any of these structures when guided by tactile sense, but have injured the ureter and bowel when working by sight among adhesions through a long incision. There is no reason why we should not abandon the inch-and-a-half incision at any moment when it seems best to do so, but the number of cases in which this incision will be abandoned will become less and less with the experience of each surgeon. I have seldom been obliged to abandon it in "interval cases" of appendicitis. In two cases in which the opening was enlarged the appendix was already outside of the abdominal cavity. In one case the incision was enlarged to allow of accurate suturing of the deep muscles, the guy-line not having been employed for controlling them. In the other case, I did not know that the appendix was already outside of the abdominal cavity, because a dense mass of adhesions bound it closely to the cecum, and not being able to find the appendix, the incision was enlarged by several inches for further exploration, while the appendix, together with the cecum, was at that moment being held in my left hand, unwittingly on my part, outside of the abdomen. It is quite true that the inch-and-a-half incision is not the proper one for employment by the surgeon who is not trained in adhesion work, but given an operator who is familiar with peritoneal adhesions, and this incision allows his patients to escape with little loss of time, and with no danger of post-operative ventral hernia, or of marring scars in the cases which are not too septic for close suturing of the wound.

It is difficult to persuade such patients that they must remain in bed for a week. I formerly kept them in bed for seventeen or eighteen days on account of tradition, but one of my gall-bladder patients, with a two-inch incision, fell dead from apoplexy while walking through the hallway of the hospital against orders, one week after the operation, and on removing the abdominal wall

which contained the scar, I tested the strength of strips of tissues which included the scar, and determined that short-incision patients had been kept too long in bed. The inch-and-a-half incision appendicitis patients were then allowed to get out of bed on the eighth day, and to resume their occupations on the tenth or eleventh day. One of my house surgeons suggested that this amounted to a week-and-a-half of time which should belong to the inch-and-a-half incision. It is unsafe to teach the use of the inch-and-a-half incision in suppurating cases of appendicitis, but I occasionally employ it even in such cases, and know that many surgeons guided by a sufficient degree of experience can do likewise.

The question is often asked if an incision two inches long would not be better than the shorter one. The smallest amount of surgery which is sufficient for the accomplishment of a certain end is the best for the patient. The inch-and-a-half incision is sufficient for routine operative treatment in the every-day appendicitis work which comes to us. Every half inch added to that incision increases the time to be spent in bed, the danger of post-operative ventral hernia, and of scar marring. There is no occasion to make an incision of any definite length for the removal of ovarian tumors, or for intestinal resection, or for any of the common intra-abdominal operations, but in early or "interval" appendicitis cases, on account of the special danger of post-operative ventral hernia, due to the relative positions of the muscles, there is special need for the smallest incision which will allow the entrance of the surgeon's finger's and exit of the infected appendix. The definite length of my incision having reference to the room required for the surgeon's fingers rather than to the size of the patient, or the extent of the adhesions, is therefore preferable to a long incision. Through the inch-and-a-half incision I have resected bowel and have made intestinal anastomosis without producing any of the symptoms of shock which are an almost invariable accompaniment of surgical operations in which the bowel is much handled through a long incision. The short incision sometimes requires more time for the surgeon, but it saves time for the patient.

The Technique of the Inch-and-a-Half Incision.

Step I. The patient is given five grains of salol to limit the extent of intestinal fermentation after operation. He is given a hypodermatic injection of codein to assist in thorough anesthetiza-

tion, and to quiet disturbance of the sympathetic system after operation. If codein is not given at the time of anesthetization, it is sometimes almost impossible to make the spasmodic abdominal muscles relax under the most complete use of ether or chloroform in operations which disturb the superior mesenteric plexus. It is a common belief that the nerves of the anal region are the last to succumb to the influence of an anesthetic, but the superior mesenteric plexus will send out a strong reflex to the muscles of the anterior abdominal wall as long as the nerves of the anal region respond to stimulation.

Step II. A space one and a half inches in length is measured off on the patient's abdomen over the normal site of the appendix, and in a line which follows the trend of the external oblique aponeurosis. The distal end of the line ends at the right margin of the right rectus abdominis muscle. A scalpel pierces the skin at each extremity of the one-and-a-half-inch line in order to mark it well. A single hooked tenaculum is inserted into each scalpel

FIG. 25.—Tenacula inserted into scalpel punctures at either extremity of the inch-and-a-half line, to put the skin upon the stretch for neat incision before operation, and for accurate suturing after operation.

puncture, and by means of two tenacula the one and a half inches of skin lying between the two punctures is put strongly upon the stretch. The reason why the incision is made in the line of the trend of the external oblique aponeurosis is because it is better to split that aponeurosis than to cross-cut it; the reason why the skin should be put upon the stretch with tenacula is because an extremely neat division of skin must be made if we expect to obtain an evanescent scar afterward.

Step III. The external oblique aponeurosis having been split with the scalpel, we divide in the same line the aponeuroses of the internal oblique and transversalis muscles, transversalis fascia, and the peritoneum. This makes a cross-cut of the transversalis and internal oblique aponeurosis, and in order to control the margins of these aponeuroses after their muscles have drawn them

away from the line of incision, a "guy-line" is inserted at the proximal angle of the wound through the aponeuroses of the transversalis and internal oblique muscles, and through the transversalis fascia and peritoneum. The guy-line is a strong strand of catgut, and after it is inserted an ordinary forceps is snapped on the loose end and left there until we are ready to close the

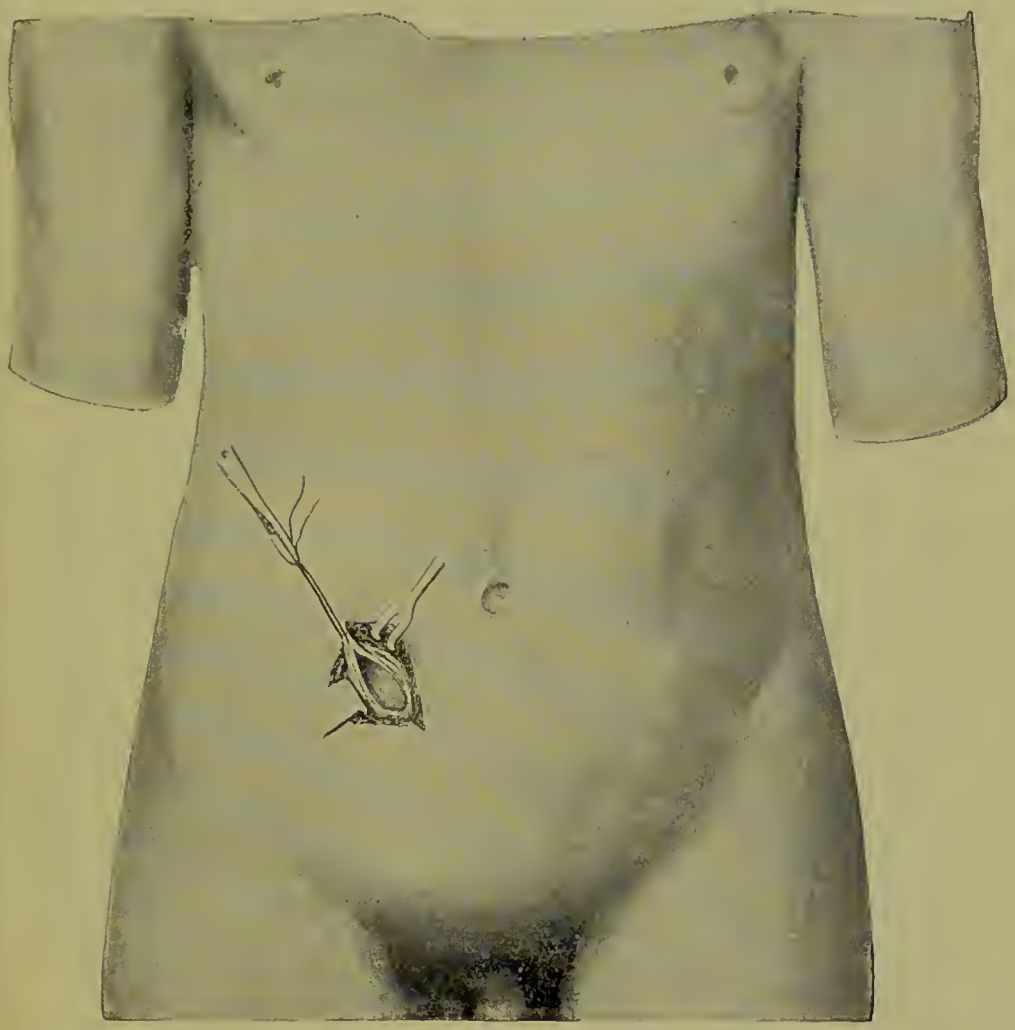

FIG. 26.—Deep aponeuroses brought into view by means of the guy-line. The cecum fills the middle space in the illustration, and the external oblique aponeurosis margins have slid away on either side of the deeper aponeuroses, which are pulled up ready for accurate suturing.

wound. The weight of the artery forceps hanging by the patient's side keeps the guy-line out of the way during the remainder of the operation. When we are ready to close the wound, an assistant, making strong traction on the guy-line, pulls the retracted margins of the divided transversalis and internal oblique apo-

neuroses up into sight so easily that they can be sutured with perfect accuracy. The suture, which is a continuous one of small chromicized catgut, includes the cut margins of peritoneum and fransversalis fascia at the same time. Some operators have tried

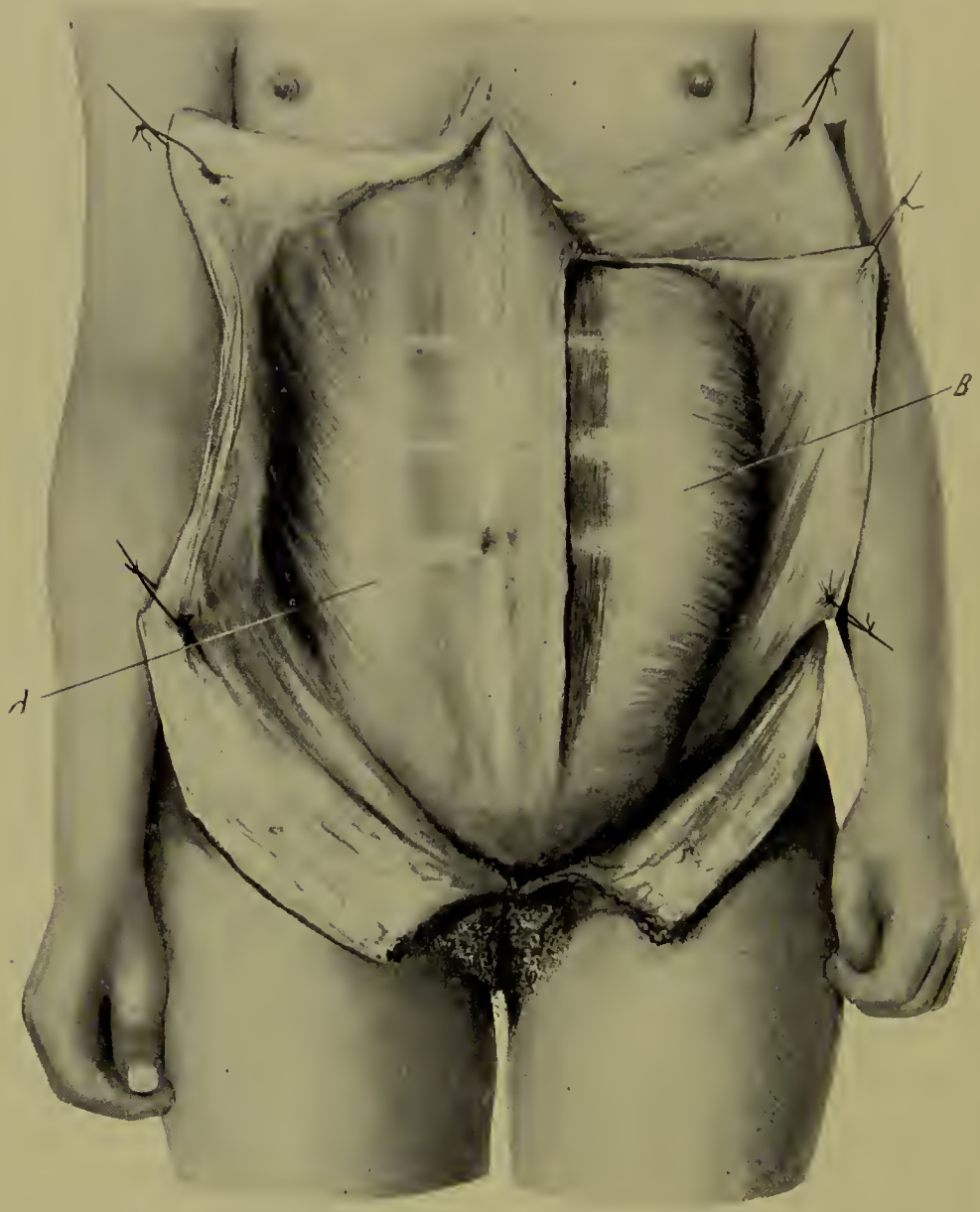

FIG. 27.—Aponeuroses involved in appendicitis operations.
A. External oblique aponeurosis. B. Internal oblique aponeurosis.

to split the transversalis and internal oblique muscles instead of making a cross-cut through them, the so-called "criss-cross operation." It is necessary to make an unnecessarily large incision and to hold the margins of the divided external oblique apo-

neurosis out of the way with retractors for that operation. The external oblique aponeurosis is scantily supplied with blood from vessels running through the loose connective-tissue planes above and below it, and if we hold its margins out of the way with re-

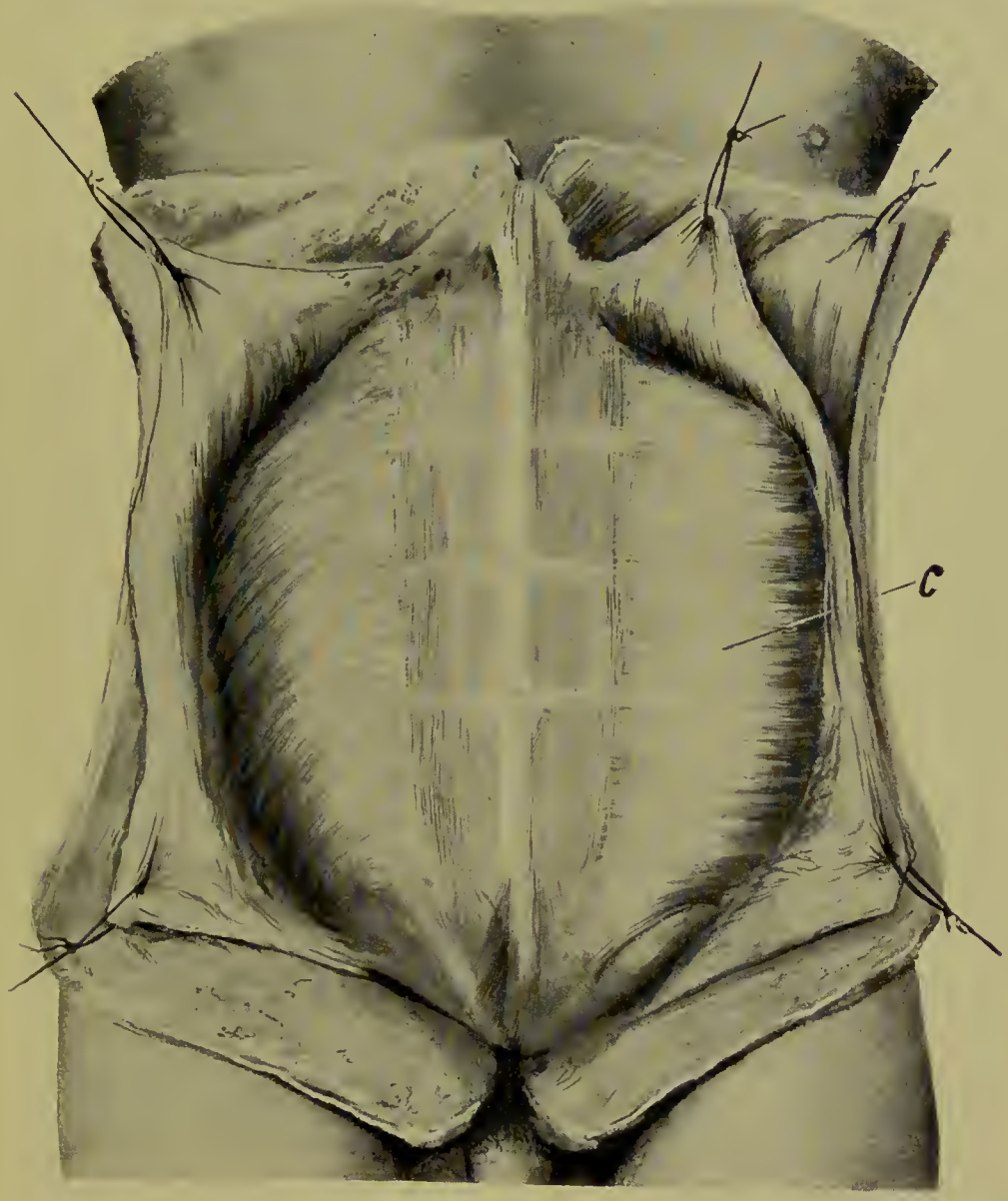

FIG. 28.—C. Transversalis aponeurosis.

tractors the vascular connections are so injured that semicircular portions of the external oblique aponeurosis corresponding to the parts that are pulled aside with retractors are quite likely to either slough or become absorbed later, thus leaving a weak spot in the abdominal wall at the site of operation. In such a case the

wound heals by primary union at first, but at the end of a few days there is evidence of suppuration beneath the skin, and on opening the wound for drainage, and examining the margins of the external oblique aponeurosis, we find them blue, ragged, and sloughing. This accident does not happen in the Bassini hernia operation, so far as my observations go, because at that point the external oblique aponeurosis receives a fairly good blood supply. In the Halsted hernia operation we approach the danger line, but at the site of operation for the removal of an appendix the external oblique aponeurosis is so poorly supplied with blood that we must be extremely cautious about separation of the loose connective-tissue attachments with retractors in operations in which this work is to be done. Sloughing of semicircular margins of external oblique aponeurosis occurred in two of my earlier operations, and I believe that surgeons must abandon operations which involve this feature.

Step IV. If the appendix is not at once felt by the finger inserted into the abdominal cavity, the ascending colon or cecum is pulled up through the wound. Colon and cecum are recognized by the senses of touch and sight. They are much lighter in color than the ileum, and are definitely distinguished by three whitish muscular longitudinal bands which one can see plainly without trained powers of observation. These three whitish longitudinal muscular bands lead straight to, and end exactly at, the appendix, so that no one could well miss it unless extensive adhesions had deeply covered the bowl. Where adhesions deeply cover the bowel, the cecum and colon can be differentiated from other structures by the sense of touch, but that requires some training, and is not to be described. If one is in doubt as to which direction to follow the longitudinal muscular bands in order to arrive at the appendix, he can excite a reversed peristalsis of the bowel by touching it with a little chloride of sodium if the bowel is not stiffened with interstitial exudate; but in most of our appendicitis cases this valuable resource of intestinal surgery is neither useful nor necessary as the appendix is pretty sure to be very near the incision, and on pulling the bare ascending colon out through the wound, the transverse colon, marked by omentum, is soon reached if one is seeking in the wrong direction. In a case in which the cecum cannot be freed from adhesions sufficiently to allow us to pull it out through the incision, I usually hunt for the appendix by inserting one finger

through adhesions between the viscera and the pelvic wall, keeping close to the wall, and separating the adherent viscera from it in a mass. The appendix is very likely to lie against the pelvic wall, and a little experience will teach one to recognize it in the midst of the conglomerate mass of other structures. By the sense of touch, one can gradually work out the appendix and bring it to the surface. If the conglomerate mass is not too large, I often bring it out upon the abdominal wall, in a lump through the inch-and-a-half incision, and then enucleate the appendix from other structures. Any part of the appendix having been found, the remainder can be readily separated from adhesions.

Step V. The appendix having been cleared from adhesions, a catgut ligature is used for ligating the mesappendix, and that structure is then cut loose. The muscular and peritoneal coats of the appendix are divided in a circle close to the cecum, leaving the inner tube of lymphoid tissue and mucosa uncut. The inner tube is then ligated with a strand of fine eye-silk, and the appendix is amputated distally from the ligature. The inner tube alone is ligated because that will suffice for closing the lumen of the appendix, and the free margins of the muscular wound in the stump will carry on repair over the weak point. Silk is used for ligating the inner tube because it makes a tiny knot, which remains longer in place than a catgut knot of the same size.

The next thing in order is to bury the stump of the appendix by bringing the walls of the cecum together over it with three or four Lembert sutures. The opposed peritoneal surfaces will adhere in a few hours so firmly that no harm will result if the stump perforates under the ligature because it is effectually sealed in. It is better to scarify the surfaces of peritoneum which are to close in a buried appendix stump. If the walls of the cecum are so stiff or fragile with interstitial exudate that the stump of the appendix cannot be pushed in and buried, the cecum is brought up against the abdominal wall, and sutured to the margins of the incision, so that, if secondary perforation takes place, bowel contents will escape through a small drainage opening in the abdominal incision which is left open for that purpose. If the cecum cannot be closed over the stump, or brought up against the abdominal wall with sutures, a drain canal, walled off with aristol, is left, leading from the cecum to the drainage opening in the abdominal wall, in expectation of a possible secondary perforation at the stump. Cases in which the stump of the removed appen-

dix cannot be neatly buried are the exception in the class of cases which make up our every-day appendix work at the present time. Before closing the abdominal incision, dry aristol is rubbed into the ragged tissues which mark separated adhesions, for the purpose of preventing septic infection or immediate re-adhesion at such points.

Step VI. When we are ready to close the abdominal incision, an assistant pulls up strongly on the guy-line, and that brings into plain view the margins of the internal oblique and transversalis aponeuroses, the transversalis fascia, and peritoneum. All of these structures are closely approximated with one continuous suture of catgut. If any one attempts to close the inch-and-a-half incision without using the guy-line or some equally good contrivance, the operation as I have planned it is a failure, and one of the prettiest operations in surgery is brought into discredit. The keystone of the inch-and-a-half-incision method is the guy-line.

After the deep structures of the wound have been closed with the continuous suture, the guy-line is cut away, and the margins of the external oblique aponeurosis are approximated with two or three interrupted sutures which penetrate into the deeper layer of tissues beneath, so that scantily nourished margins of aponeurosis will fit snugly and thus receive nutrition by contact. The sutures which are placed in the external oblique aponeurosis must not be tied tightly because of the danger of compression-anemia, which would interfere with good repair in a structure which needs such care on the part of the surgeon.

Step VII. The last step in the operation consists in closing skin and fat in such a way as to make an evanescent scar, and this cannot be done unless tenacula are again inserted into the angles of the wound, and the skin put upon the stretch until skin margins are drawn absolutely together without wrinkling, and without the interposition of any subcutaneous fat. A fine Hagedorn needle and a continuous suture of very small catgut are used for uniting the closely approximated skin margins. The needle and suture include the whole thickness of the true skin, and nothing else besides the skin. If any fat is included in the suture, it will slowly give way under pressure. The sutures then being looser, the margins of skin will draw apart a trifle, and the intended effect is lost. The scar will draw out into a broad line within a few weeks, and will remain permanently as

a scar. The patient will not be ready to get out of bed on the eighth day, and to resume his occupation a week and a half after the date of operation. I do not include fat in any suture for the complete closure of any abdominal incision. Before the last loop

FIG. 29.—Evanescent scar following the inch-and-a-half incision.

of catgut is tied in the continuous skin suture, the fat layers are approximated by manual pressure applied on the outside of the wound. Any blood or irrigating fluid is forced out by such pressure. The last loop is tied, and after that the fat margins remain together by atmospheric pressure as securely as the boy's leather sucking disk clings to a stone, and on the same principle. Many

of us overlooked for years the rôle which atmospheric pressure could be made to play in evenly approximating thick layers of adipose tissue in a closed wound. In order to make sure of an evanescent scar it is well to use catgut which will be absorbed in about ten days, and then the function of sutures is carried on for ten days more by a strip of gauze laid upon the scar line, and saturated with flexible collodion. The collodion gauze prevents a stretching out of the new repair tissue. A wound so treated may be at the end of a year entirely invisible on ordinary inspection, and it is a triumph of artistic surgery as compared with the scars of the days of life-or-death surgery. My plan for obtaining an evanescent scar and for making adipose wound margins remain approximated by atmospheric pressure was developed about four years ago.

The Technique in the Treatment of Appendicitis with Widespread Infection.

Step I. If the patient is pulseless, or very weak from overwhelming septic intoxication, it is well to obtain a pulse with hypodermatic injections of strychnia, if possible, before operating. In some moribund cases a very fair pulse will appear under the influence of ether alone, but strychnine is invaluable in such cases.

Step II. The patient is placed in Trendelenburg's posture, unless the surgeon has become very expert in treating complicated septic abdominal cases, and is guided by highly trained tactile sense. Trendelenburg's posture allows the operator to work very easily by sight, and much unnecessary handling of bowel is avoided because atmospheric pressure packs the bowel so well out of the way when the abdomen is opened that loops of intestine are not constantly bulging into the field of work. Trendelenburg's posture may be obtained without having a special table for the purpose, if a long-backed chair is placed face down upon an ordinary table, and the patient is pulled up on the inclined plane made by the back of the chair until his legs hang over the rounds, and keep him from sliding down the incline. Before the abdomen is opened the bowels will be observed to gravitate towards the diaphragm if a proper degree of inclination has been given to the patient.

Step III. An incision three or four inches long is made in the line of the trend of the external oblique aponeurosis, the incision traversing the normal site of the appendix.

Variety A, Step IV. If there is general septic peritonitis without adhesions, the appendix will be found stiff and hard, bobbing about in peritoneal fluid unless it has already sloughed. The appendix having been removed, the whole abdominal cavity is flushed out with a few quarts or gallons of hot physiological saline solution at a temperature of about 100° F., inserted through a long tube of large calibre.

Variety B, Step IV. If the general peritoneal cavity is filled with pus and loose lymph flakes, one or two pints of hydrogen dioxide are first injected into various parts of the abdominal cavity for breaking up clinging pus and lymph, and two or three minutes later the whole abdominal cavity is flushed out with a few gallons of hot physiological saline solution.

Variety C, Step IV. When the abdominal cavity is filled with masses of infected, coagulated lymph, which cause general adherence of the viscera, with or without multiple pools of liquefied lymph, the surgeon's hand must be inserted and carried over the whole abdominal cavity, to separate all adhesions before using hydrogen dioxide and physiological saline solution, as in Variety B. The patient will probably die while this is being done, but I kept one such patient alive by holding a bottle of nitrite of amyl constantly to his nose until all adhesions were separated and the abdominal cavity flushed out. This patient was moribund, apathetic, and pulseless half an hour before operation, but a slight strychnine pulse was obtained, and the patient recovered, but still carries a fecal fistula due to the sloughing of gangrenous patches of colon.

Variety D, Step IV. When a walled-in abscess is found in the inguinal region, the abscess cavity is very thoroughly cleansed with hydrogen dioxide and flushed out with saline solution. This allows us to search for the appendix, and for multiple abscesses in the vicinity, without danger of infecting the general peritoneal cavity when that is exposed through separated adhesions. I believe that the danger of infecting the general peritoneal cavity in this way is greatly overestimated, judging from a pretty full personal experience with such cases, but nevertheless I do not neglect to throw about the case all of the precautions which belong to tradition. In olden times we rested content with the opening of one abscess in such cases, and some of the patients died because another and smaller abscess remained hidden away in adhesions. Other patients died because an infected mass of appendix re-

mained to cause slow poisoning. The question as to whether any given appendix is to be removed or left in such a case must always remain a question for decision by the particular operator who is at work, and who knows whether his qualifications make it safer or more dangerous for that particular patient to have an adherent appendix removed. There is no rule in the matter.

Variety E, Step IV. If a swollen, fragile appendix cannot be separated from adhesions without tearing it to pieces, it may be split with the handle of a scalpel, and the lymphoid tissue and mucosa are then removed with a curette, if any portions of such structures have remained.

Step V. When, after the removal of the appendix, it is found that the cecum is too fragile to hold sutures for burying the stump, or too badly disorganized to resist necrotic changes, the cecum is brought up to the abdominal wall and sutured to one margin of the abdominal incision in such a way that the intestinal contents will escape immediately through the drainage opening when the cecum gives way a few days later. If sloughs have formed in colon or ileum, such damaged bowel is sutured to the anterior abdominal wall near the incision, and for the same reason. In cases in which the cecum cannot be brought up against the anterior abdominal wall, aristol is rubbed on the presenting structures which are to form the wall of the drainage canal leading from damaged cecum to the anterior abdominal wall. The aristol in a few minutes walls off a canal so well that the patient is safe against infiltration infection among intestinal loops, or along the planes of the structures of the abdominal wall.

Step VI. A drainage wick not quite as large round as the little finger, and surrounded by gutta-percha tissue, is inserted as far as the iliac fossa, or into the pelvis, to obtain capillary drainage. The capillary gauze drain will have done work enough at the end of twenty-four hours, and may then be removed. The drainage canal will be by that time so well walled in that discharges from below will escape readily to the surface, as a rule. If there is any doubt on that point, it will be well to carry a single narrow strip of gutta-percha tissue to the bottom of the wound on the end of a probe, and this will further act by capillarity—capillarity between the walls of the drainage canal and the line of least resistance along the smooth gutta-percha. In my work there are three things which are particularly avoided—the use of drainage tubes, counter-openings for drainage, and gauze packing. No

one can question the value of the drainage tube in the practice of the Prices, but it forms a part of their system, which system as a whole has given most brilliant results. I do not use the drainage tube because the hydrostatic pressure of a column of fluid in the tube needs to be relieved by constant attention on the part of trained nurses or assistants, and the mechanical effect of such pressure in the neglected tube is to keep the structures at the bottom of the tube bathed in fluid, for the counter-pressure of viscera is not sufficient to fully overcome hydrostatic pressure. By turning the power of capillarity into use, we may make it take the place of counter-openings for drainage. Counter-openings add more surgery to a class of cases in which the patient must be asked to bear as little surgery as possible. With a small drainage wick sucking away at any point in the lower part of the abdominal or pelvic cavity, the opposed peritoneal planes must exert capillary power at any distance, and draw free fluid from all directions toward the point at which the greatest force is constantly being exerted. There is nothing theoretical in my views on this point. They are based on the most practical results gained in every-day work with a class of cases in which it would seem as though separate collections of fluid must form in various dependent parts of the abdominal cavity. I wish to have as few foreign bodies as possible in the abdominal cavities of my appendicitis patients after operation, feeling that if a large drainage tube were placed in my own abdominal cavity this morning, I would not feel well to-morrow morning; and a weak patient is no stronger than I am. Several drainage tubes placed through counter-openings make a heavier load yet for the patient. On this same ground I do not use gauze packing in the abdominal cavity. A mass of gauze packing in my own abdominal cavity to-day would interfere with my work by to-morrow. Gauze packing is soon filled with lymph, which coagulates and fills the meshes, because the mechanical effect of the absorbent dressing on the outside of the abdomen is not sufficient to lift fluids rapidly through the large absorbent mass below. The coagulating lymph causes peritoneal surfaces to adhere firmly to the gauze packing, so that when it is removed, the healing tissues are rudely disturbed, and intestinal loops are pulled into all sorts of malposition. Worst of all is the result of leaving a large surface to be attacked by streptococci when the gauze packing is removed. Colon bacilli apparently stop work on exposure of their nests,

and then streptococci and other bacteria take their place and poison the patient by slow septicemia, if the surgeon cannot take good enough precautions against their ravages. The cavity left after removal of the gauze packing is a particularly favorable nidus for the development of streptococci. Iodoform gauze is still less useful than plain absorbent gauze, because the iodoform and the substances employed for fixing it in the gauze interfere with its capillarity, which is already handicapped when the drain is too large. A fallacy appears in the reasoning against the use of large stiff drainage tubes, and of gauze packing, if we make one comparison, and say that a septic wound minus harmful drainage apparatus is more dangerous than a septic wound plus harmful drainage apparatus—a statement which is quite true ; but harmful drainage apparatus can be supplanted by harmless resources. A drainage wick which is small, soft, and supple, and which adjusts itself to curves, yielding to the pressure of bowel in various directions, and constantly at work by capillary power, does not produce much disturbance in the abdominal cavity, and it drains well for as long a time as large tubes and gauze packing drain poorly. All sorts of drains are soon walled off in the abdominal cavity by peritoneal exudate, and their usefulness then ceases. It is sometimes stated that blood-clot will not pass through a drainage wick, but neither will blood-clot pass through a drainage tube ; fluid-blood will pass out through a capillary wick (not through gauze packing) before it has time to clot, and more readily than it will pass out through a drainage tube. Pus will not pass through the drainage wick freely, but I do not use either wick or tube for draining off pus from wounds in soft parts, depending rather upon pressure of tissues to force pus to follow the line of least resistance. In cases where pus is to be drained off, a single narrow strip of gutta-percha tissue often helps to guide the fluid along the line of least resistance.

Step VII. In closing a long incision the steps are practically the same as in closure of the inch-and-a-half incision, with the exception that an opening is left for the drainage wick, and aristol is rubbed into the opening about the wick in order to wall off the various tissue planes against infiltration. A small drainage opening left in the abdominal incision is preferable to a larger one unless we need to give exit to intestinal contents from more than one sloughing point in bowel. I always inform patients that they are quite likely to have a ventral hernia at the site of an appen-

dicitis operation if the wound has been drained, because the transversalis and internal oblique muscles draw their margins steadily away from the site of the unsutured drainage opening, and because the nerves which supply the muscles in the vicinity of the wound do not then get their ends together. For the same reason it is difficult to repair such a hernial opening, because the tissues for reconstruction of the abdominal wall at that point are not there. The resource of suturing the cecum to the abdominal wall at the site of operation has prevented the formation of ventral hernias in all of my drained appendicitis wounds, in which it was employed, because the cecum remains attached there, fixed in the weakest point, and it shunts loops of bowel that would otherwise work through.

Step VIII. When the drainage wick is removed, twenty-four hours after the operation, the treatment consists in injecting balsam of Peru into the drainage canal twice daily. If there is a large amount of purulent discharge, I use hydrogen dioxide before injecting the balsam, until granulations form, but the hydrogen dioxide must then be omitted because of its tendency to follow leucocytes into the granulation tissue. When a drainage canal has contracted to form a narrow sinus, all suppuration can sometimes be stopped abruptly by one injection of iodoform and glycerine in the proportions of one to ten, the walls of the granulating sinus then adhering by secondary union. After long incision operations, it is best to keep the patient in the recumbent position for at least three weeks.

Step IX. After any operation for appendicitis, with either the long or short incision, I give nothing but hot water or hot peppermint water for twenty-four hours, because the process of digestion is inhibited by the disturbance of the abdominal sympathetic nerves, and fermentation of the bowel contents ensues, with the production of gas, which may cause much distress, and the toxines are irritating. Saline cathartics, which are hygroscopic, are passed through the alimentary tract, or injected into the colon by high enemata on the day after the operation for the purpose of causing rapid exosmosis of intra-peritoneal toxine-bearing fluids, and carrying off toxines and gas. The process is repeated as often as septic symptoms call for it. If the colon is much distended with gas, it is emptied through a long rectal tube. If the stomach is also distended with gas, it is emptied through a long stomach tube. This can be easily accomplished with little repugnance on

the part of the patient if the stomach tube is first lubricated with palatable sweet oil flavored with oil of wintergreen, and presented to the patient in a clean white saucer, the patient being asked to chew the tube, and to swallow it at leisure. The oil of wintergreen tastes so good that the patient swallows the tube with a relish. The fauces may be first sprayed with cocaine if the patient is particularly sensitive. While I am very much opposed to the use of opium after abdominal operations as a rule, there are places in which the unrest and over-stimulation of the sympathetic system can be quieted with codein to the advantage of the patient, provided that we do not allow the peritoneum and bowel to stop work.

The dietary and general treatment for the comfort of the patient after operation I prefer to leave to the family physician, if it is possible for him to be in attendance, and to share the pleasure and work of carrying a distressing case of appendicitis to complete recovery.

ONE HUNDRED CONSECUTIVE OPERATIONS FOR APPENDICITIS.

A list of consecutive appendicitis operations, beginning with my first and ending with my one hundredth case, is here given as illustrative of the progress that was made by the appliance of new resources. If some of the first cases could be replaced by a series operated upon subsequently to this group the list would include fewer fatal cases, but would not be so valuable for purposes of instruction. The reason why there were so few operations done at the outset of the first attack, is because I have no *clientele* of my own, and the patients came to me from physicians who had tried palliative treatment first. Latterly there has been a larger proportion of early infection cases, and these will be included in reports to be made elsewhere.

Number.	Age.	Sex.	Number of Acute Attacks and Condition of Appendix.	Stage and Complications.	Operation.	Post-Operative Complications.	Result.
1	38	M.	One? Unknown.	Acute. Small abscess.	Long incision. Abscess opened. Tube drainage.	General septic peritonitis.	Died of septic peritonitis 20 hours later.
2	20	M.	One? Unknown. Concretion found in pus.	Acute. Enormous abscess.	Long incision. Abscess opened. Tube drainage.	General septic peritonitis.	Died three weeks later. Septicemia.
3	22	M.	One. Unknown.	Acute. Large abscess.	Abscess opened. Tube drainage. Long incision.		Recovery. Second operation as Case No. 51.
4	37	M.	Several since age of 16. Perforated near tip.	Acute. Small adhesions.	Long incision. Removed appendix. Buried stump. Closed wound.		Recovery.
5	22	M.	Several. Three round sloughs on point of perforation.	Acute. No adhesions.	Long incision. Removed appendix. Buried stump. Closed wound.		Recovery.
6	42	M.	Several. Hypertrophic. Inner tube ulcerating.	Chronic. No adhesions.	Short incision. Removed appendix. Buried stump. Closed wound.		Recovery.
7	10	M.	One. Slough near tip on point of perforation.	Acute. Omentum adherent around appendix.	Short incision. Removed appendix. Buried stump. Closed wound.		Recovery.
8	26	F.	One. Perforation. Gangrene. Two concretions.	Acute. Abscess. Large mass of new adhesions.	Long incision. Appendix removed. Cecum too fragile for burying stump. Wick drainage.	Making excellent recovery. Suddenly developed bowel obstruction at end of a week.	Died one week later. Intestinal obstruction.
9	44	M.	Several. Bent in a loop opening at each end into cecum. Hypertrophic.	Chronic. Extensive old firm adhesions hid appendix.	Long incision. Appendix removed. Stump buried. Closed wound.	Sloughing of external oblique aponeurosis. Opened skin and drained.	Recovery.

Number.	Age.	Sex.	Number of Acute Attacks and Condition of Appendix.	Stage and Complications.	Operation.	Post-Operative Complications.	Result.
10	14	M.	Two. Perforation at tip.	Acute. General suppurative peritonitis. Abdomen full of green pus and masses of coagulated lymph.	Long incision. Appendix removed. Flushed with H_2O_2. Wick drainage.		Recovery.
11	26	M.	One. Tip adherent to parietal peritoneum.	Chronic. Adhesions at tip only.	Short incision. Appendix removed. Buried stump. Closed wound.		Recovery.
12	23	M.	Two. Two concretions.	Chronic. Extensive old firm adhesions hid appendix.	Long incision. Closed wound.	Sloughing of external oblique aponeurosis. Opened skin wound and drained.	Recovery.
13	47	F.	Several during 15 years. Appendix gone, leaving pyogenic sac containing piece of apple core encrusted with phosphates.	Chronic. Pyogenic sac containing brown pus. Cecum destroyed. Extensive old firm adhesions.	Long incision. Curetted sac. Separated adhesions. Drained, wick.	Septicemia. Formation of much brownish serum in wound.	Died three days later. Shock.
14	37	M.	Several. Hypertrophic. Small ulcerating points in mucosa.	Chronic. No adhesions.	Short incision. Removed appendix. Buried stump. Closed wound.	Superficial suppuration necessitated opening skin wound.	Recovery.
15	26	M.	Two. Appendix sloughed in part. Two concretions.	Acute. Abdomen filled with pus and gas. Gangrenous appendix in a walled-off space. Perforating slough of cecum and colon.	Long incision. Removed appendix. Flushed abdomen with H_2O_2 and saline solution. Sutured perforating bowel to margins of abdominal incision. Wick drainage.		Recovery. Small fecal fistula yet. Two years elapsed.
16	36	F.	Several. Appendix sharply bent, and bound there by adhesions.	Chronic. Firm old adhesions binding various structures about appendix.	Long incision. Removed appendix. Buried stump. Closed wound.		Recovery.
17	30	F.	Appendix normal. Mistake in diagnosis.	Bound in with firm adhesions resulting from typhoid perforation.	Long incision. Removed appendix, believing it to be infected. Buried stump. Closed wound.	Superficial suppuration. Opened skin wound.	Recovery.

18	28	M.	Tuberculous appendix.	General peritoneal tuberculosis, most marked in appendix region.	Long incision. Removed appendix. Buried stump. Wick drain.		Recovery from operation. Recovering from tuberculous peritonitis.
19	49	F.	Inner tube gone. Outer tube hypertrophic, connective tissue principally.	Chronic as to appendix. Adherent to septic oviduct. Extensive firm old adhesions. Acute general suppurative peritonitis.	Mid-line incision. Removed uterine adnexa and appendix. Flushed abdomen with H_2O_2 and saline solution. Wick drain.	Ventral hernia. Wound had to be left open because whole peritoneum was suppurating.	Recovery, with ventral hernia. Small. No truss worn.
20	40	F.	Several. Inner tube ulcerating. Five concretions. Mucosa absent. Sub-mucosa replaced by fibrous connective tissue.	Chronic. Adherent to mesentery only.	Incision $1\frac{1}{2}$ inches long. Buried stump. Closed wound.		Recovery.
21	35	F.	One. Wholly gangrenous. One concretion.	Acute. Abscess. Large mass of new adhesions. Portions of cecum and colon sloughing.	Long incision. Removed appendix. Sutured sloughing bowel to margin of abdominal incision after flushing vicinity with H_2O_2 and saline solution. Wick drain.		Recovery.
22	19	M.	One. Greatly swollen. Gangrenous almost wholly. Several perforations.	Acute. General septic peritonitis. Enormous abscess, in which loops of ileum hung free from adhesions.	Long incision. Removed appendix. Flushed with H_2O_2 and saline solution. Wick drain.		Recovery.
23	40	M.	One. Appendix wasted to a thread, excepting distal half inch, which was distended to shape and size of a marble.	Chronic. Extensive old firm adhesions.	Short incision. Removed appendix. Closed wound.	Had used buried silk-worm gut sutures instead of catgut, and they worked out later.	Recovery.
24	21	F.	Two. Whole inner tube gangrenous. Perforation near cecum.	Acute. Abscess. Large mass of new adhesions.	Long incision. Appendix removed. Fragile cecum sutured to margin of abdominal incision after flushing with H_2O_2. Wick drain.		Recovery.
25	38	M.	Two. Sloughing fragments only.	Acute. General septic peritonitis with rhexis of colon and ileum. New adhesions everywhere.	Long incision. Fragments washed out with H_2O_2. Fragile cecum sutured to margins of abdominal wound.		Recovery with tiny fistula ; sometimes closed, sometimes open.

Number.	Age.	Sex.	Number of Acute Attacks and Condition of Appendix.	Stage and Complications.	Operation.	Post-Operative Complications.	Result.
26	40	F.	Several during 20 years. All structures hypertrophic. Punctate ulceration of inner tube.	Acute. Fragile local adhesions.	Long incision. Removed appendix. Buried stump. Closed wound.	Another case in which I tried buried silk-worm gut sutures. They worked out later.	Recovery.
27	36	F.	Several. Ulceration of inner tube. Two concretions.	Acute. Adherent to mesentery at tip. Adhesion band at middle of appendix.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
28	43	M.	Whole appendix gangrenous. Perforated.	Acute. General peritonitis, with general adhesions walling off numerous widely distributed collections of pus.	Long incisions on both sides of abdomen for evacuation of abscesses. Flushed with H_2O_2. Wick drainage.		Death two hours later. Shock.
29	44	M.	Several. Two very large concretions. Hypertrophic appendix not actively inflamed. Mucosa almost perfectly preserved. Endothelial coat of arteries hyperplastic. Arteries large and tortuous. Submucosa composed of fibrillated connective tissue.	Chronic. Old adhesion band from tip of appendix to mesocolon had formed a ring, through which nearly whole of ileum had slipped. Nearly whole length of ileum strangulated. Gangrenous, with large perforations.	Long incision. No operative work could help the patient.		Death few hours later from original cause. Operation made no impression either way.
30	28	M.	Several slight attacks. Fibrous replacement of portions of inner tube. Otherwise normal.	Chronic. Mesappendix contracted firmly at middle segment with hyperplastic band. No adhesions.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
31	25	M.	Two. Perforation at middle segment. Two old scar strictures nearly occluded lumen.	Acute. Abscess. Extensive new adhesions.	Short incision. Removed appendix. Buried stump. Flushed with H_2O_2. Wick drain.		Recovery.
32	33	M.	One. Ulceration of inner tube. Lumen full of pin worms (oxyuris).	Chronic. No adhesions.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.	Wound suppurated. Due to injury from retractors.	Recovery.

33	28	M.	Two. Appendix divided into three nodes by internodal complete scar strictures. Nodes distended with thick opaque fluid.	Acute. Extensive old firm adhesions.	Long incision. Removed appendix. Buried stump. Closed wound,	Another case in which I tried buried silk-worm gut sutures. Sutures worked out later.	Recovery.
34	28	M.	One. Round ulcer penetrating inner tube. Smaller round ulcer nearly penetrating inner tube.	Acute. Contraction of middle segment of mesappendix. No adhesions.	Long incision. Appendix removed. Fragile swollen cecum would not allow insertion of sutures for burying stump. Stump ligated like an artery.	Primary union followed nearly week later by suppuration within abdominal cavity. Opened, Wick drain.	Recovery.
35	41	F.	One ? Inner tube sloughing. Perforation between layers of mesappendix. Whole distended with pus, which was escaping through the thin mesappendix.	Acute. Abscess. Intense general peritonitis of eight hours' duration. Extensive new adhesions.	Long incision. Removed appendix. Flushed with H_2O_2. Sutured swollen cecum to margin of abdominal incision. Wick drain.		Recovery.
36	15	M.	Two. Appendix wasted to a string, excepting distal inch, which was tense with interstitial exudate.	Chronic. Extensive old firm adhesions.	Long incision. Removed appendix. Could not bury stump. Closed wound.	Primary union followed few days later by suppuration within abdominal cavity.	Recovery, except for fistula (not fecal) for several months.
37	24	F.	One. Tuberculous appendix.	Chronic. Extensive old firm adhesions. Peritoneum of cecum studded with tubercle.	Incision $1\frac{1}{2}$ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
38	32	M.	Several. Ulceration of inner tube. One scar stricture nearly occluded lumen near proximal end.	Chronic. Adhesions abundant but not firm.	Incision $1\frac{1}{2}$ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
39	46	F.	Several ? Lumen almost occluded and filled with coagulated mass of remnants of cells from mucosa. Mucosa compressed. Lumen surface ragged and eroded. Submucosa densely fibrous. Peritoneal coat thickened.	Chronic. Found this appendix bound in adhesions while operating for removal of a chronically infected oviduct.	Mid-line incision. Removed appendix. Buried stump. Wick drain.		Recovery.

Number.	Age.	Sex.	Number of Acute Attacks and Condition of Appendix.	Stage and Complications.	Operation.	Post-Operative Complications.	Result.
40	11	F.	One? Round slough, penetrating middle segment of inner tube.	Acute. Well marked new adhesions. Adhesion band from tip of appendix to mesocolon was strangulating cecum.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
41	18	M.	Several. Hydrappendix. Scar stricture near cecum closed lumen. Lumen distended with several drachms of clear thin fluid.	Chronic. Extensive old firm adhesions.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
42	29	M.	One. Appendix nearly disappeared. Small portion of lumen and portion of outer tube remained.	Chronic. Extensive old firm adhesions.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
43	25	F.	Normal appendix. Mistake in diagnosis.	Tuberculosis of peritoneum not including that of appendix particularly.	Incision 1½ inches long. Removed appendix. Buried stump. Drained wound.	Hernia appeared in wound some months later. Hernial opening closed by Dr. Coley.	Recovery.
44	20	M.	One. Stiff with interstitial exudation. Inner tube not examined.	Chronic. No adhesions.	Incision 1½ inches long. Removed appendix. Buried stump. Drained wound.		Recovery.
45	30	M.	Two. Appendix in two parts. A short healed stump attached to cecum. Another portion 1¼ inches in length, situated about two inches from the stump, made a round ball kept alive by adhesions.	Acute. Firm old adhesions from pelvis to diaphragm.	Long incision. Removed appendix. Could not bury stump. Ligated it. Wick drain for oozing from torn adhesions.	Septic peritonitis.	Recovery.
46	27	F.	Several. Appendix broadened out into a large pyogenic sac containing brownish pus and a large round concretion. Inner tube structures gone.	Chronic. Extensive old firm adhesions.	Long incision. Removed pyogenic sac. Wick drain for oozing from adhesions.	Another case in which silk-worm gut sutures slowly worked out.	Recovery.

47	40	M.	Two. Several small ulcerating points in inner tube. Two concretions.	Chronic. Adhesions to border of omentum.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
48	21	F.	Several. Tense and congested. Mucosa nearly gone.	Acute. No adhesions.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
49	30	F.	One? Unknown.	Acute. Enormous abscess. Extensive new adhesions.	Long incision. Evacuated abscess only on account of condition of patient. Tube drainage.		Recovery, but carries an appendix which must come out, judging from symptoms.
50	36	M.	Several. Inner tube replaced by connective tissue at several points.	Chronic. No adhesions.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound. Made another incision at same sitting to examine descending colon.		Recovery.
51	25	M.	Several. Same case as No. 3. Outer tube whole except for scar at tip. Hypertrophic. Inner tube sloughing.	Acute. Extensive old firm adhesions. New adhesions encapsulating thin purulent fluid.	Long incision. Removed appendix. Could not bury stump. Wick drain. H_2O_2.		Recovery.
52	37	M.	Two. Half inch long. Marble-shaped from distension. Stricture complete at cecal end.	Chronic. No adhesions. Tuberculosis of peritoneum in vicinity of appendix.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.	Tuberculosis extended to whole peritoneum? And involved lung six months later.	Recovery from operation. Has tuberculosis.
53	34	M.	One. Appendix in two parts from former sloughing. Separated part kept alive by adhesions.	Chronic. Old adhesions binding appendix to cecum only.	Incision 1½ inches long. Removed appendix. Buried stump. Had to enlarge wound to suture layers. Guy line not used.		Recovery.
54	14	M.	Two. Whole mucosa desquamating. Two round sloughs had nearly perforated appendix.	Acute. Mass of new adhesions.	Incision 1½ inches long.		Recovery.
55	18	M.	One. Perforation near tip.	Acute. Abscess. Mass of new adhesions.	Long incision. Removed appendix. Buried stump. H_2O_2. Wick drain.	Phlebitis of left leg, after getting out of bed.	Recovery.

Number.	Age.	Sex.	Number of Acute Attacks and Condition of Appendix.	Stage and Complications.	Operation.	Post-Operative Complications.	Result.
56	30	M.	Several. Gangrenous and perforated at two points. Remainder of appendix replaced by fibrous tissue.	Acute. Abscess. Extensive old and new adhesions.	Long incision. Removed appendix. Could not bury stump. H_2O_2. Wick drain.		Recovery.
57	23	M.	Several. Outer tube hypertrophic. Inner tube nearly gone.	Chronic. Extensive old adhesions.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
58	25	M.	One. All structures gangrenous excepting proximal half inch.	Acute. Thin new adhesions.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
59	46	M.	One. Sclerotic stump.	Chronic. Extensive old adhesions.	Removed stump. Buried cecal portion.		Recovery.
60	46	M.	Several. Occluding structure at cecal end. Lumen of remainder distended with brown fluid. Mucosa gone. Lymphoid honeycombed.	Chronic. Extensive old adhesions.	Incision 1½ inches long. Removed appendix. Buried stump, but cecum thick and fragile.	Primary union for eight days. Suppuration within abdomen. Opened. Wick drain.	Recovery.
61	36	M.	Distended with interstitial exudate. Otherwise normal.	Chronic. Associated with chronic colitis.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
62	16	M.	One. Mucosa desquamating.	Acute. New adhesions.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
63	18	M.	Several. Ulceration of inner tube about a large concretion.	Chronic. Adhesions to posterior surface of cecum.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
64	24	M.	One. Stricture at middle segment encapsulating thin fecal matter and mucus.	Chronic. No adhesions.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
65	12	M.	One. Appendix replaced by a string of masses of tubercle.	Acute. General tuberculous peritonitis.	Incision 1½ inches long. Appendix not worth removing.		Recovery from tuberculosis.

66	39	F.	One. Sclerotic remains.	Chronic. Extensive old adhesions.	Long incision. Patient very fleshy. Removed appendix. Wick drain.		Recovery.
67	37	M.	Cancer of cecum involving appendix. Mistake in diagnosis.	Cancer involving cecum as far as ileo-cecal valve.	Incision 1½ inches long. Removed appendix, cecum, and ileum at valve in one mass. Lateral anastomosis.	Superficial suppuration of wound.	Recovery.
68	15	M.	One. Perforation near cecum.	Acute. General septic plastic peritonitis binding all surfaces together. Appendix free in large cavity containing gas only.	Long incision over appendix and in mid-line to separate adhesions for flushing with $H_2 O_2$ and saline solution. Removed appendix. Ligated stump.		Recovery.
69	29	M.	Several. Perforation near tip. Two old scar strictures.	Acute. Phlebitis of left leg from sub-peritoneal infection going across pelvis. Bowel adhering to pelvic floor. Adhesion where perforation emptied sub-peritoneally. Septic fluid among new adhesions.	Incision on both sides of abdomen to facilitate separation of adhesions. Appendix removed. Buried stump. Wick drain.		Recovery.
70	25	M.	One. Distal sixth sloughing. Rest of inner tube ulcerating. One large concretion near tip.	Acute. Abscess. Abundant new adhesions.	Incision 1½ inches long. Removed appendix. Could not bury stump. Ligated. $H_2 O_2$. Wick drain.		Recovery.
71	29	M.	One. Rhexis. All structures infiltrated with blood.	Acute. Abscess. Extensive new adhesions.	Incision 1½ inches long. Removed appendix. Could not bury stump. Ligated. $H_2 O_2$. Wick drain.	Septicemia. Acute right lobar pneumonia began on 8th day after operation.	Recovery.
72	60	M.	Tuberculosis of appendix.	Tuberculosis of all structures of cecum and ascending colon.	Long incision. Did not remove appendix. Wick drain.		Recovery. Tuberculosis disappearing. 8 months elapsed.
73	30	M.	Several. Scar stricture at junction of proximal and middle thirds encapsulated; half a drachm of muco-pus.	Chronic. Local old adhesions.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.

Number.	Age.	Sex.	Number of Acute Attacks and Condition of Appendix.	Stage and Complications.	Operation.	Post-Operative Complications.	Result.
74	52	M.	Two. Proximal two inches sloughing.	Acute. Abscess. Mass of new adhesions. General septic peritonitis.	Long incision. Removed appendix. Could not bury stump. Ligated. Wick drain. H_2O_2. Did not use saline solution for flushing.	Recovering until 4th day. Bowel obstruction supervened.	Died on 5th day. Bowel obstruction.
75	31	M.	Several. Extremely hypertrophic. Old perforation near cecum opened into chronic pyogenic sac.	Chronic. Small pyogenic sac filled with muco-pus. Extensive old adhesions.	Incision 1½ inches long. Had to enlarge it to work by sight. Removed appendix. Wick drain.		Recovery.
76	44	F.	Several. Scar stricture ¼th inch from distal extremity. Inner tube ulcerating near cecum.	Chronic. Pyosalpinx and contact infection of appendix from the oviduct. Extensive old adhesions.	Long incision. Removed appendix. Buried stump. Removed pus tube. Wick drain.		Recovery.
77	53	F.	None. One concretion in lumen of normal appendix.	Ovarian tumor.	Incidentally discovered concretion while operating for removal of tumor and pushed it into cecum. Did not remove appendix.		Recovery.
78	26	M.	Several. Mucosa desquamated.	Acute. Well marked new and old adhesions.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
79	23	M.	Several. Ulcerating about two white concretions. Shape and size of muskmelon seeds.	Chronic. Adhesions at tip of appendix only.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
80	21	M.	Two. Gangrenous and fragmentary.	Acute. Suppurative nephritis of right kidney. Abscess. New adhesions.	Long incision. Removed gangrenous fragments. Wick drain.		Died 5 days later. Acute suppurative nephritis.
81	23	M.	Two. Mahogany-red from rhexis. Distended with several drachms of brown pus. Inner tube honeycombed. Stricture at cecum.	Chronic. Two weeks after last attack. No adhesions.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.

82	27	F.	Several. Sclerotic stump.	Chronic. Small ovarian tumor.	Incision in middle line. Removed remains of appendix. Buried stump. Removed cyst. Closed wound.		Recovery.
83	20	F.	Appendix replaced by masses of tubercle. History of inflammation beginning at appendix.	General peritoneal tuberculosis.	Long incision. Separated adhesions. Appendix not worth removing. Wick drain.		Recovery.
84	28	M.	Several. Ulceration of inner tube.	Chronic. Firm old adhesions.	Incision $1\frac{1}{2}$ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
85	20	F.	One. Appendix nearly gone.	Acute, multiple abscesses. Subperitoneal and intra-peritoneal on both sides of lower abdomen and pelvis.	Incision on both sides of abdomen for separation of adhesions, and flushing with $H_2 O_2$ and saline solution. Wick drainage.		Recovery.
86	34	M.	Several. Ulceration of inner tube. Lymphoid nearly gone.	Chronic. Extensive old adhesions.	Incision $1\frac{1}{2}$ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
87	26	M.	Two. Three complete stricture nodes. Internodes distended with purulent fluid.	Chronic. Extensive old adhesions.	Incision $1\frac{1}{2}$ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
88	21	M.	Several. Gangrenous and perforated at tip. One large concretion.	Acute. Few adhesions. Acute general septic peritonitis.	Long incision. Removed appendix. Ligated stump. Could not bury it. $H_2 O_2$. Saline solution. Wick drain.	Phlebitis of right leg on day after operation.	Recovery.
89	30	M.	One. Appendix gone.	Chronic. Extensive old adhesions, causing bowel obstruction.	Incision $1\frac{1}{2}$ inches long. Separation of adhesions from cecum colon, ileum, and omentum.		Recovery.
90	24	M.	One. Appendix gangrenous and perforated at several points.	Acute. Abscess. Extensive new adhesions.	Long incision. Did not remove appendix, because of its close connection along the iliac vein. $H_2 O_2$. Wick drain.		Recovery.
91	33	M.	Two. Appendix gangrenous.	Acute. Abscess. Extensive new adhesions.	Long incision. Portions of appendix removed piecemeal. $H_2 O_2$. Wick drain.		Recovery.

Number.	Age.	Sex.	Number of Acute Attacks and Condition of Appendix.	Stage and Complications	Operation	Post-Operative Complications.	Result.
92	21	M.	Appendix twisted upon itself, damming mucus in the lumen. Normal otherwise. A dislocated appendix.	Patient weak from continued vomiting. No evidence of inflammation about appendix.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
93	35	M.	Two. One very large concretion. One small one. Great hypertrophy of muscularis.	Acute. Extensive old and new adhesions.	Incision 1½ inches long. Removed appendix. Could not bury stump. Ligated it. Closed wound.	Primary union followed by intra-abdominal suppuration five days later. Opened. Wick drain.	Recovery.
94	19	M.	One. Mucosa ulcerating.	Acute. New adhesions to parietal peritoneum only.	Incision 1½ inches long. Removed appendix. Buried stump. Closed wound.		Recovery.
95	21	M.	Two. Mesappendix gangrenous. Appendix swollen, but not yet gangrenous.	Acute. Abscess. Extensive old and new adhesions.	Long incision. Removed appendix. Buried stump. H_2O_2. Wick drain.		Recovery.
96	26	F.	Many attacks of violent appendicular colic. Appendix normal, containing two concretions.	No complications. Giving evidence of inflammation about appendix.	Mid-line incision for examining ovaries. Pushed concretions out of appendix into cecum. Did not remove appendix.		Recovery.
97	24	M.	Two. One pea-sized slough of inner tube near cecum.	Acute. Extensive old and new adhesions.	Incision 1½ inches long. Removed appendix. Ligated stump. Could not bury it. Closed wound.	Primary union, followed ten days later by intra-abdominal abscess. Opened. Wick drain.	Recovery.
98	21	M.	Two. Perforation at middle. Inner tube sloughing.	Acute. Abscess. Extensive new adhesions.	Long incision. Removed appendix. Ligated stump. Could not bury it. H_2O_2. Wick drain.		Recovery.
99	30	F.	Several. Two scar strictures. Mucosa gone.	Chronic. Old adhesions from pelvis to diaphragm.	Long incision. Removed appendix. Ligated stump. Wick drain for hemorrhage from adhesions.		Recovery.
100	35	F.	Two. Distal four-fifths of inner tube gone.	Chronic. Adherent to right ovary and tube.	Mid-line incision for hysteropexy. Removed appendix. Buried stump. Closed wound.		Recovery.

Summary.

Fifty-nine of the cases were without infection, excepting in the immediate vicinity of the appendix, and although many of these cases involved extensive operative work on account of adhesions there were no deaths in the series.

Seven of the cases were of peritoneal tuberculosis, involving the appendix, and apparently having origin at the appendix in six of them. All recovered from the operation. Three recovered and three others are recovering from the peritoneal tuberculosis. In one the tuberculosis continued.

One case of cancer involved the appendix and cecum. I exsected all of the cancerous structures, and the patient has had no recurrence of the disease to date. Fourteen months elapsed.

Six cases of intense general septic peritonitis, with the whole abdominal cavity bathed in a flood of pus, were of the type that belonged to the most fatal class until very recently. In this group, however, I lost only one case, the moribund patient dying of shock two hours after the operation.

Four cases with intense general septic peritonitis not marked by the presence of pus gave two deaths. One of these cases (No. 29 in the list) does not really belong in these statistics at all, as the case was one of gangrene of a strangulated ileum, but it must be included because I happened to remove the appendix, which was right at hand and which was valuable as a peculiar specimen, though it had no bearing on the outcome of the case. The other death resulted from bowel obstruction, in a case in which the whole serosa had apparently been destroyed by the peritonitis.

Twenty-three cases were of the walled-off abscess form, presenting the most varied complications, from that of a small excapsulation of pus up to abscess cavities containing quarts of pus in one or more compartments and reaching from the pelvis to the liver, but separated from the remaining uninfected peritoneal cavity by protecting lymph walls. There were five deaths in this group. Two of them in my first two appendicitis cases, tube drainage having been used and the resources of hydrogen dioxide and saline solution not employed. Both patients died of septicemia. Three of the patients died after I had adopted wick drainage and the use of hydrogen dioxide and saline solution. One of these died of acute suppurative nephritis, which began a few hours before the operation. Another died of intestinal obstruction from adhesions which could not be separated at the time of operation on account of the patient's condition ; and the third one, weak from several months of septicemia, died of shock.

If the seven appendicitis patients in this list who died could have had

the benefit of the methods resulting from a fuller experience I believe that three of them would have recovered. I feel that the death-rate in one hundred such cases as this list contains should not be more than four or five per cent., notwithstanding the fact that many of the cases were in a condition which seemed almost to prohibit operative interference.

Ventral hernia has appeared in only two of the cases, because of my method of closing the abdominal wound. One of the hernias appeared in an inch-and-a-half-incision case which had to be drained, and the hernial opening has since been closed by secondary operation. The other hernia appeared in one of the general suppurative peritonitis cases, in which a long incision had to be kept widely open. This hernia is controlled by a truss, as it cannot be easily corrected by operation.

Fecal fistula has persisted in one case only (No. 15), and there are two cases of superficial fistula which the patients do not wish to have repaired as yet.

Mistakes in diagnosis were seldom made in suspected cases of appendicitis. Thus, in the series of one hundred cases everything is included in which I made a diagnosis of appendicitis before the operation, and error was made but three times. No. 17 had a normal appendix surrounded by adhesions, due to typhoid perforation of the bowel. No. 43 had a normal appendix in a case of general peritoneal tuberculosis. No. 67 had cancer of the cecum, involving the appendix. The consequences of these three mistakes in diagnosis are as follows :

(1) The patient with typhoid adhesions has been decidedly benefited by separation of the adhesions which had caused constipation almost to the point of obstruction.

(2) The peritoneal tuberculosis patient is cured.

(3) The cancer patient is perfectly well to date, fourteen months after the operation, with no sign of recurrence as yet.

No doubt the proportion of cases in which one would find difficulty in making a diagnosis is larger in a general medical practice, for almost all of the appendicitis cases which are sent to the surgeon have first been differentiated as such by the general practitioner, and that gives the surgeon an evident advantage. Then, again, the proportion of appendicitis cases in a general medical practice fluctuates markedly. One physician of my acquaintance has had sixteen cases of appendicitis during the past five years, diagnosis having been verified by operation in all of them. Another physician of large practice assures me that he has never seen a case of appendicitis. The death-rate in cases of appendicitis treated without operation fluctuates also. Thus, one physician has recently reported fourteen attacks of appendicitis in fourteen patients treated medically, with six deaths. Another reports eighty-

five cases with fourteen deaths, and another reports twenty cases without a death. I would like details in such a report. In this connection I wish to say that the expressions "case" and "attack" must not be used synonymously, because we are to expect that "when one attack is done the patient's troubles have just begun." Statistics from countries in which appendicitis is classed as typhlitis cannot be used by us. I have been through the wards of large European hospitals and have been shown series of typhlitis cases which included ordinary catarrhal colitis, coprostasis, and tuberculous enteritis, but not appendicitis. Data bearing upon the subject of appendicitis should be collected only from physicians who differentiate these cases distinctly.

I hope that another century will see the establishment of a medical court with a judiciary which has no other occupation than weighing evidence and giving rulings upon that large part of medical knowledge which can be classified.

If judges upon the same bench sometimes find it difficult to know what is good law, how much more difficult must it be for the members of our profession to deduce the truth and the right from a mass of incomplete testimony and hearsay evidence that is presented to us in good faith by medical advocates, but which requires for correct analysis a judicial temperament and long training in methods. Yet every one of us is assumed to be not only a judge but a good one and impartial. Matters of fact that have been settled beyond all peradventure in one locality are bandied about as subjects for debate in other localities. If nothing more than property were involved this would be a matter of comparatively small moment, but human life is directly at stake, because physicians must carry into practice their individual decisions. From appendicitis to vaccination and from antitoxine to vivisection there are questions which demand rulings from a local, state, national, and international medical court.

CHAPTER V.

NOTES.

THE ACTION OF VARIOUS SOLVENTS ON GALLSTONES.

FOUR years ago I experimented with various gallstone solvents for the purpose of simplifying the operation in cases in which an impacted gallstone is found in the common duct, my intention being to avoid the operation of section of the duct, or the danger of injury to the duct in crushing a gallstone in position, by injecting solvents through a soft catheter introduced into the common duct; the gall-bladder having first been fastened to the skin to form a fistula. Now, however, with the use of aristol to wall off a drainage canal, and the use of the drainage wick to draw away bile rapidly by capillarity, the operation has been reduced to such a simple one that I do not care to follow out the idea of dissolving impacted stones; but the experiments which were made at that time as to the solubility of gallstones are interesting. The object was to find a liquid which could be best applied through a temporary biliary fistula; hence, solvents destructive to living tissues were excluded, and the experiments were therefore limited to gallstones consisting largely of cholesterin, since there seemed no possibility of dissolving inorganic concretions with noncorrosive solvents.

The solvents tried were divided into four classes, viz.:

(1) *General solvents.*—Liquids known to possess the power of dissolving many organic substances of different constitutions. These include the "text-book solvents," or those mentioned in the books as readily dissolving cholesterin.

(2) *Natural solvents.*—Those which are said to hold cholesterin in solution in the body.

(3) *Allied solvents.*—Those which, being akin to cholesterin in chemical constitution, should, according to the law of "like dissolves like," be good solvents for cholesterin.

(4) *Indicated solvents.*—Those which being akin in chemical constitution to solvents found to act well, are those indicated as possibly able to act better.

The general organic solvents are: Acetic acid, acetic ether, acetone, alcohol, amyl alcohol, benzene, carbon bisulphide, chloroform, ether, petroleum ether or naphthol (three kinds were used), and xylol. Ether is excluded as it boils below blood heat. All the others were tried, as were also glycerine, paraffin oil, and olive oil.

The natural solvents are the soaps (salts of the fatty acids—two kinds were used) and the salts of the bile acids.

The allied solvents. Since cholesterin is a benzene derivative, and contains a hydroxyl group, and is nearly allied to the turpenes and camphors, the following solvents were tried: turpentine oil, eucalyptol, phenol, naphthol (alpha and beta), disolved in alcohol, menthol in carbon bisulphide, Caucasian petroleum.

The indicated solvents are bromoform, carbon tetrachloride, and ethylene dichloride, which were used because chloroform was found to be a good solvent. Other substances used were chloral hydrate and alcoholate, for either of these mixed with camphor liquefies it. But they were found to be without action on cholesterin.

Altogether twenty-nine solvents were used. The gallstones examined were from six patients:

(1) Black stones; ash small.
(2) Yellow-brown stones; ash small.
(3) Gray stones; ash small.
(4) Brown stones; ash large.
(5) Yellow-gray stones; ash small.
(6) White stones; ash small.

The first experiments were made with set No. 1, and the others were tried as specimens were obtained. As it seemed most desirable to use a natural solvent, soaps were first tried. Preliminary experiments showed that their solvent power was slight. Thus:

GALLSTONES—SET NO. 1.

Solvent.	Temperature.	Time.	Action.
Ivory soap dissolved in water	100°C.	1 min.	Slight.
Strong solution	100°C.	3 min.	Slight.
Same solution	27°C.	72 hrs.	Slight.
Ivory soap dissolved in 20 per cent. alcohol	37°C.	46 hrs.	Small stone broke up on shaking.
Ivory soap dissolved in 20 per cent. alcohol	37°C.	45 hrs.	No change.
Castile soap dissolved in 20 per cent. alcohol	38°C.	2½ hrs.	Slight.
Castile soap dissolved in 20 per cent. alcohol	38°C.	24 hrs.	No more.

Preliminary experiments were tried with a number of other solvents, with the result that glycerine and menthol were rejected. Experiments were next tried with weighed stones and measured liquids. To obtain an equal weight of solid for use with each solvent it would have been necessary to cut or powder the stones, but it semed better to test them in the natural state, though this made necessary the use of stones of unequal weight for the various tests. To diminish the effect of this difference on the results, a large excess of the solvent was used—always the same volume of each solvent in each set of experiments. The method was to note the time at which the solvent and the stone were brought together; then to plunge the test tube containing them in an oil-bath, kept in an incubator at blood heat, and to note at intervals the appearance of the stone. In this way tables were made, from which the final result is copied below. The action was taken as complete when the stone was thoroughly broken up, for it is unnecessary that it should be completely dissolved; and this is the time given in the table below. At first the effect was not noted at very short intervals, so that here "the time" is only the maximum result. In later experiments the effect was noted every minute for the first few minutes, and later at gradually increasing intervals.

AT BLOOD HEAT.

GALLSTONES—SET NO. I.

Solvent.	Weight.	Time.	Dissolved per minute.
Alcohol and acetic acid	.021 gm.	48 hrs. plus.	
Alcohol and potash	.020	27 hrs. plus.	
Benzene	.020	24 hrs. minus.	
Carbon bisulphide	.030	1.30	.0003
Carbon bisulphide	.016	1.30	.00015
Carbon tetrachloride	.020	0 hrs. 7 min.	.003
Chloroform	.017	24 hrs.	
Eucalyptol	.019	27 hrs.	
Paraffin oil	.018	27 hrs.	
Petroleum (American)	.023	24 hrs.	
Petroleum (Caucasian)	017	27 hrs.	
Phenol	.017	48 hrs.	
Xylol	.023	24 hrs.	

GALLSTONES—SET NO. 2.

Solvent.	Weight.	Time.	Dissolved per minute.
Alcohol and acetic acid	.023 gm.	48 hrs. plus.	
Alcohol and potash	.024	27 hrs. plus.	
Benzene	.025	0 hrs. 56 min.	.0005
Carbon bisulphide	.020	0 hrs. 15 min.	.0013
Carbon bisulphate	.016	0 hrs. 6 min.	.0027
Carbon tetrachloride	.020	0 hrs. 5 min.	.004
Chloroform	.047	0 hrs. 15 min.	.003
Eucalyptol	.021	0 hrs. 15 min.	.0014
Paraffin oil	.024	2 hrs. 15 min.	
Petroleum (American)	.023	27 hrs. plus.	
Petroleum (Caucasian)	.018	24 hrs.	
Phenol	.024	2 hrs. 15 min.	
Xylol	.020	48 hrs.	
	.027	1 hrs.	.0004

GALLSTONES—SET NO. 2.

Solvent.	Weight.	Time.	Dissolved per minute.
Camphor in alcohol	.033 gm.	21 hrs.	
Carbon bisulphide	.077	0 hrs. 7 min.	.011
Carbon tetrachloride	.034	0 hrs. 7 min.	.005
Chloroform	.037	0 hrs. 3 min.	.012
Naphthol in alcohol (alpha)	.029	19 hrs.	
Naphthol in alcohol (beta)	.029	19 hrs.	
Petroleum (Caucasian)	.074	3 hrs. plus.	

GALLSTONES—SET NO. 3.

Solvent.	Weight.	Time.	Dissolved per minute.
Carbon bisulphide	.076 gm.	0 hrs. 10 min.	.008
Carbon tetrachloride	.038	0 hrs. 7 min.	.005
Chloroform	.039	0 hrs. 5 min.	.012

From the column giving—for the best solvents only—the weight dissolved per minute, it is seen that these are carbon bisulphide and tetrachloride, and chloroform. These were therefore more closely compared in testing the remaining gallstones, and bromoform and ethylene dichloride were also tried. It was found that the gallstones in set No. 4, which contained much inorganic substance, were not much attacked by any of the solvents, although some of them were deeply colored by these stones.

GALLSTONES—SET NO. 5.

Solvent.	Weight.	Time.	Dissolved per minute.
Bromoform	.0235 gm.	0 hrs. 30 min.	.0008
Carbon bisulphide	.064	12 min.	.005
Carbon bisulphide	.025	6 min.	.004
Carbon bisulphide 10 per cent. and tetrachloride 10 per cent.	.065	12 min.	.005
Carbon bisulphide 50 per cent. and chloroform 50 per cent.	.061	15 min.	.004
Carbon tetrachloride	.029	12 min.	.0024
Chloroform	.0215	6 min.	.0035

GALLSTONES—SET NO. 6.

Solvent.	Weight.	Time.	Dissolved per minute.
Bromoform	.032. gm.	24 min.	.0013.
Carbon bisulphide	.020.	1 min.	.020.
Carbon bisulphide	.031.	not much attacked.	
Carbon bisulphide 90 per cent. and tetrachloride, 10 per cent	.020.	2 min.	.010.
Carbon bisulphide 90 per cent. and chloroform 10 per cent	.025.	3 min.	.008.
Carbon tetrachloride	.029.	8 min.	.0036.
Chloroform	.027.	3 min.	.009.

Carbon bisulphide and chloroform still surpass all others, and the addition of carbon tetrachloride to the bisulphide is seen to be no improvement. The two best solvents were now particularly compared with regard to their action on gallstones in set No. 1.

GALLSTONES—SET NO. 1.

Solvent.	Weight.	Time.	Dissolved per minute.
Carbon bisulphide	.024. gm.	55 min.	.0005) mean.
Carbon bisulphide	.020.	42 min.	.005) .023.
Carbon bisulphide	.145.	23 min.	.070)
Chloroform	.024.	60 min.	.0004) mean.
Chloroform	.020.	70 plus.	.0003) .015.
Chloroform	.154.	35 plus.	.044)

Here it is seen that the large stones were dissolved in much less time than the small ones; that the time for unit weight should be less in the case of the large stones is comprehensible, for the proportion of the outer, deeply colored, difficultly soluble layer is less. Besides the thorough breaking up of the large stone does not involve its breaking into such small pieces as are obtained

from a small stone. But this would hardly account for the difference observed. It seems probable that the larger stones are less compact than the smaller ones, *i. e.* that they have a lower specific gravity. But it must not be forgotten that the smaller stones of the same set differ enormously in themselves—witness the failure of chloroform on a small No. 1 stone in set No. 1, and the failure of bisulphide in a stone in set No. 6. These results place carbon bisulphide at the head of the list.

Pure cholesterin was next prepared and tested with the solvents. It was found that there was such a parallel between its solubility and that of the gallstones that new solvents might fairly be tested with it instead of with the stones. The solvents dissolved cholesterin in the following order, small quantities, approximately equal, being used in test tubes:

Carbon bisulphide—instantly on touching.
Chloroform—almost instantly.
Carbon tetrachloride—almost instantly.
Bromoform—almost instantly.
Ethylene dichloride—more slowly.
Benzene—more slowly still.
Xylol—about as benzene.
Turpentine—more slowly.
Amyl alcohol—more slowly than turpentine.
Alcohol—slowly.

The petroleum had little action; paraffin oil and glycerine, none.

On the strength of this parallel, the solvents acetone, acetic ether and olive oil, and gall acids were rejected because they had but little action on cholesterin. The acids were especially prepared from ox-gall, and dissolved in alcohol. Their potassium salts were also tried.

A conspectus of the action of the best solvents on the different stones is as follows:

GALLSTONES—SET. NO. 1.

Solvent.	Stone 1.	Stone 2.	Stone 3.	Stone 5.	Stone 6.	Mean.
Carbon bisulphide..	.023.	.0065.	.008.	.0045.	.020.	.0124.
Chloroform.....	.015.	.0065.	.012.	.0035.	.009.	.009.
Carbon tetrachloride.....	.003.	.004.	.005.	.0024.	.0036.	.0036.

Conclusions.

The best solvent is carbon bisulphide, though for some stones chloroform may prove better (see stone, set No. 3). A mixture of the two in equal quantities would probably have the best general effect. Stones from the same subject differ enormously in solubility, as much as do stones from different subjects; but in the latter case the difference is regular, in the former only occasional. Any solvent which will not instantly dissolve cholesterin may be rejected as a solvent for gallstones, although it is possible that a solvent may readily dissolve cholesterin and yet not act readily on gallstones. This gives a ready means of testing any solvents which may suggest themselves. We have no evidence that gallstones are ever dissolved by substances taken internally for that purpose by patients. Olive oil is very frequently administered. There are several reasons why it does not act therapeutically as a solvent. (1) Oil cannot be expected to travel up the gall-ducts from the duodenum because the peristaltic action of the ducts is toward the duodenum from the liver, and this peristaltic action is presumed to be unceasing. (2) If oil could travel against the peristaltic effort of the gall-ducts and enter an open gall-bladder—many are not open—it would be at once mixed with bile. (3) Undiluted sweet oil in which I kept gallstones for weeks at various temperatures produced no appreciable effect beside a softening of the external layers of some stones. So unimportant was its action, that it was not thought worth while to include it in the further tests.

What sweet oil does do is to carry toxines out of the alimentary tract pretty rapidly, and it relieves patients of the element of intoxication from that source. The fact that biliary colic often ceases after the administration of sweet oil is a coincidence to be expected if we simply remember that such colic ceases as quickly without the aid of sweet oil. Biliary colic means extraordinary efforts on the part of the muscular walls of the gall-bladder and ducts to force out an irritating substance, and the colic ceases when a stone has passed out of the canal or when it has failed to engage and has moved back into the gall-bladder, where it may remain quiescent for days, months, or years.

Drugs given internally, on the theory that they will prevent any further formation of gallstones, are handicapped if gallstone formation is due to fermentation of mucus in the biliary tracts, because fermentation is caused by bacteria only; and the colon

bacillus, which is apparently the principal culprit, is not influenced so far as we know by any drug after that drug has been exposed to digestive processes and has been excreted by the liver. Post-mortem examination of patients who were supposed to have been cured of gallstones has revealed the fact that stones were still in the gall-bladder. Personally, I would much prefer to depend upon our successful new surgical resources, rather than suffer the agony of a single attack of gallstone colic, in the hope that some fanciful line of treatment might reach and dissolve a set of gall-stones snugly hidden away in the gall-bladder. Medical treatment which would aim to prevent the formation of gallstones must apparently have for its first object the prevention of the development of colon bacilli in the gall-bladder, and we have no available resources for that purpose as yet.

THE INFLUENCE OF REMAINS OF THE EMBRYONIC VITELLINE DUCT IN THE PRODUCTION OF MOIST NAVELS, AND OF ECZEMATOID INFLAMMATION ABOUT THE NAVEL.

THE primitive intestine and the umbilical vesicle in the human embryo are in connection through the vitelline duct until the abdominal plates close at about the end of the sixth week of fetal life, and shut in that part of the duct which unites navel and umbilical intestinal loop. The umbilical intestinal loop having

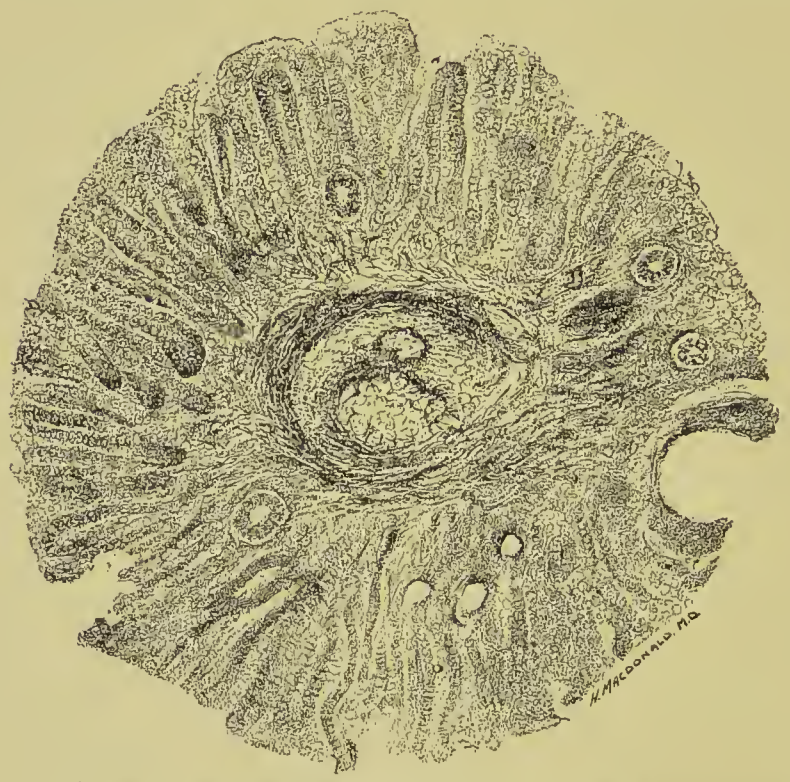

FIG. 30.—Microscopic section from eczematoid navel, showing mucous follicles developed from embryonic remains.

been drawn into the abdominal cavity, subsequent development of the alimentary tract causes rupture or thinning of the remains of the vitelline duct, which should then become absorbed. Sometimes omphalo-mesenteric remains, instead of undergoing absorp-

tion, become developed in whole or in part, and form intestinal diverticula; open intestinal fistulæ at the navel; fibrous intra-abdominal bands, with or without mesenteric blood-vessels; intra-abdominal retention cysts; and so-called adenomata of the navel, consisting of hypertrophic intestinal gland tissue. Such well defined structures have attracted the attention of many observers, but there is another and larger class of cases in which microscopical remains of the vitelline duct at the navel cause annoying complications, which do not present features pointing to their real origin. Tiny embryonic remains at the navel, which develop columnar epithelium or tubular glands, may empty their secretions externally, and this mucus, though small in amount, is sufficient to keep the navel and the skin in its vicinity constantly moist. In children with delicate skins, the exposed mucus decomposes, and sometimes causes an irritation resulting in dermatitis, or "eczema of the navel," which may extend to the formation of a reddish, angry-looking patch as large as the hand, just as it does from the secretion from a patent urachus. Such a dermatitis is rather intractable under the ordinary plans of treatment because the original cause persists, and though palliative treatment will lessen or control the amount of irritation, there is a tendency toward exacerbations of local dermatitis from time to time until the skin becomes less sensitive as the patient grows older. It is a very easy matter to hook up the navel with a tenaculum in such a case, and to excise the little button of tissue which contains microscopic remains of the vitelline duct.

MALIGNANT ISLANDS AT THE NAVEL, OCCURRING SIMULTANEOUSLY WITH MALIGNANT DISEASE OF THE ABDOMINAL OR PELVIC ORGANS.

WHEN malignant disease is present in the abdominal or pelvic organs, the navel sometimes becomes involved in disease of the same type. I have obtained notes from four cases of this sort, and in two cases microscopic remains of the vitelline duct were found in abundance in the involved navels. The other two were

FIG. 31.—Embryonic remains in a navel which was elsewhere carcinomatous.

not examined with reference to that point, as my attention had not at that time been attracted to the subject. In these cases the secondary malignant disease had occurred at a point particularly rich in embryonic cells, and this may have some bearing on Cohn-

heim's theory relative to the development of tumors from latent embryonic cells.

The causative elements of sarcomatous and of carcinomatous disease situated at a distance from the navel, apparently found their way through the blood current to the navel in four patients, and the navels of these patients became infected islands of disease, similar in character to that which was present in the other structures at the time.

The four cases were as follows :

Case 1.—A woman, seventy years of age ; diagnosis of cancer of the pylorus. Six months from the beginning of her symptoms the patient began to have pain at the navel, and she noticed a small lump there, which became very hard, and about as large as a chestnut, bluish-red in color, and with a smooth superficial, ulcerating external surface that

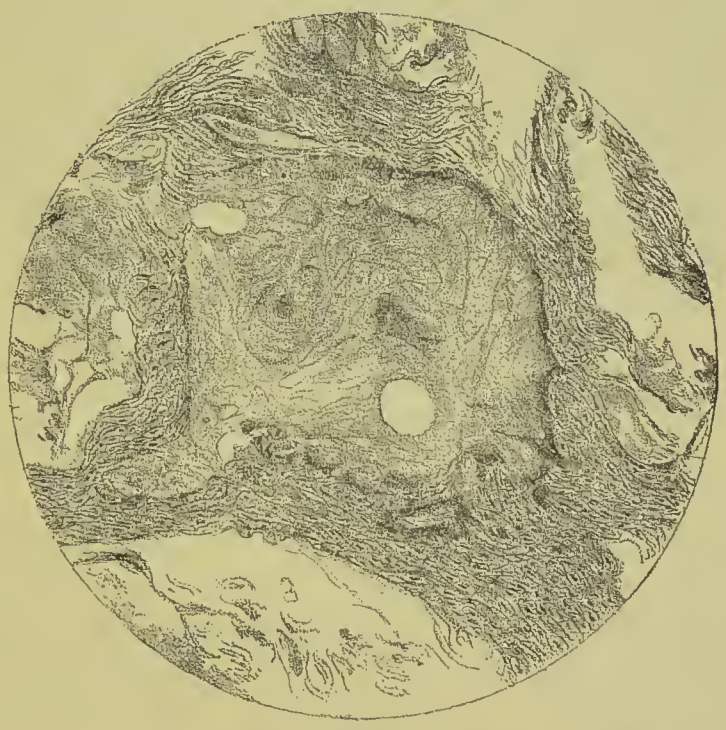

Fig. 32.—Adeno-carcinoma of navel from Case 1.

discharged a little straw-colored serum. I removed the diseased navel, and found that it was not in contact with anything but normal structures. The patient died two months later with ordinary symptoms of cancer of the pylorus, but a necropsy was not permitted. The disease at the navel was adeno-carcinoma, evidently developing from embryonic gland tissue.

Case 2.—A man, fifty-four years of age ; carcinoma of the glands of the left groin for two years ; intra-abdominal symptoms of malignant disease. For four weeks a small, fungating mass, which was the seat of much pain, had been developing at the navel. The navel, as a whole, was not enlarged or hardened in this case, but from its centre sprang a tuft of purplish-red granulations about as large as a small pea. I removed the navel, and at the same time made an exploratory opening

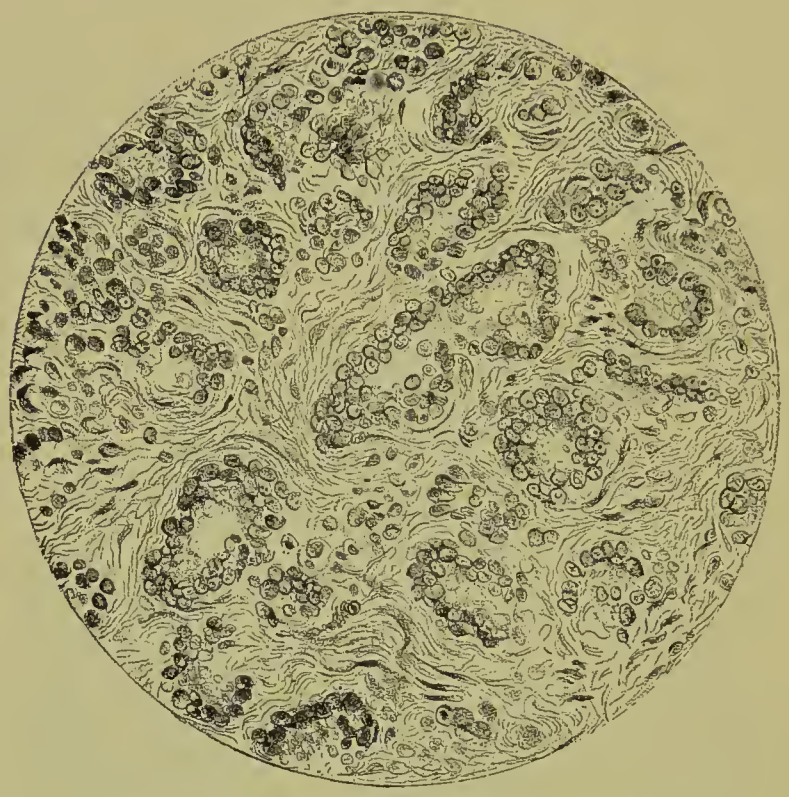

Fig. 33.—Adeno-carcinoma of navel from Case 2.

for an examination of the abdomen. The omentum was the seat of colloid carcinoma, but there were no adhesions of omentum to furnish a route for infection to the navel. The disease of the navel was adeno-carcinoma, and the specimen contained numerous minute dots of intestinal gland tissue.

Case 3.—Extract from a letter from Dr. Grinnell, of Burlington, Vermont : "Patient, a male, sixty-eight years of age ; diagnosis of cancer of the pylorus. Eight months before the patient's death, the navel became hard and painful, and the discharge from it was malodorous. Five months later, the liver began to enlarge, and death was caused by cancer of the liver, as determined at necropsy. The disease at the navel had remained confined to that point, while the disease elsewhere made progress."

Case 4.—Extract from an article by Dr. Daniel Lewis, in the *New York Medical Record*, October 12, 1889: "The patient was suffering from a disease of the fundus of the uterus, diagnosticated as sarcoma. While this was in progress malignant disease attacked an umbilical hernial sac, evidently beginning at the navel and extending from there to the tissues of the sac. Examination of the navel showed it to be the seat of remains of the vitelline duct. Section of one part of the neoma showed large, round-cell alveolar sarcoma, and the deeper section showed a mixture of round and spindle cells."

A LAST RESORT HERNIA OPERATION.

A DOG pulled out some of the sutures which I had placed in his abdominal wall after an experimental operation, and part of a loop of bowel descended into the wound during the night. This loop of bowel seemed to be adherent to the wound margins, and it was allowed to remain undisturbed for observation. Healing took place, and there seemed to be no further progress of hernia. The dog was not disturbed by the fixed bowel. It seemed probable that fixation of bowel at a hernial opening could be utilized as a surgical resource in some few cases of hernia in which other and simpler resources had failed. I tried further experiments on rabbits, suturing various portions of bowel to the margins of artificial hernial openings, and found that the animals did not suffer any inconvenience. There has been no opportunity as yet to apply this resource in a femoral or inguinal hernia, but I have employed it in one large umbilical hernia and in five appendicitis cases to prevent the progress of ventral hernias after large drained wounds.

In none of these cases has hernia appeared as yet, the cases dating back twenty-four months, twenty-four months, twenty-two months, twenty months, eighteen months, and three months, respectively. The distal end of the cecum is the best part of the bowel to make fast at an opening in the right inguinal region, because it is less likely to kink as a result of peristaltic movements than any other part of the bowel. The danger from kinking or twisting from fixed bowel is real, but not great, if we are to judge from numerous cases in which intestine is adherent in large hernial sacs, and as a result of various acute inflammatory processes in the abdomen and pelvis which leave strong adhesions behind; nevertheless the resource in question is not adapted to any of the ordinary curable cases of hernia while so many operations, practically free from danger, are at our service.

The technique of the operation for fixation of bowel at a hernial opening, consists in suturing the bowel to the margins of the opening with sutures carried through the peritoneal and

muscular coats of the bowel. The parietal peritoneum is first stripped away from the abdominal wall for a short distance, so that bowel peritoneum unites with connective tissue of the abdominal wall only, otherwise the approximated surfaces of

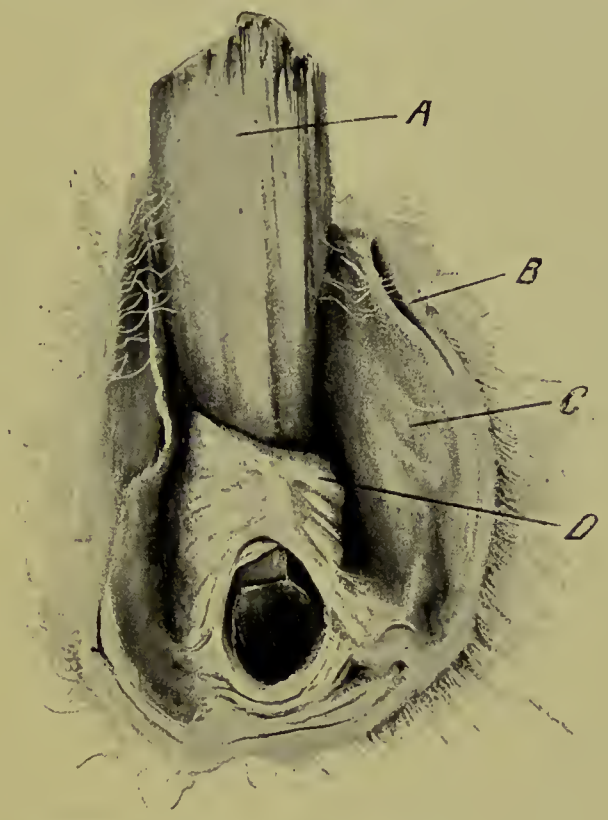

FIG. 34.—Segment of bowel united to margins of hernial opening (Rabbit).

A. Stick of wood inserted to show lumen of intestine.
B. Skin and muscles.
C. Peritoneum.
D. Segment of attached intestine. Longitudinal ridge marks site of mesentery.

peritoneum would be apt to advance conjointly at the weak spot. The mechanical effect of fixed bowel is to shunt loops of movable bowel away from the weak spot, and against solid walls on either side.

THE EXPERIMENTAL PRODUCTION OF ILEAL INTUSSUSCEPTION WITH CARBONATE OF SODIUM.

At an abdominal operation in which normal peristalsis is retarded, it is sometimes difficult to know in which direction the bowel runs, and various substances have been employed for exciting a quick peristalsis, either normal or reversed. In the hands of Dr. Senn a satisfactory reversed peristalsis has been obtained by touching the peritoneal surface of the bowel with chloride of sodium, but recently a note went the rounds of the medical press, to the effect that sodium carbonate was still more efficient. In order to test the efficacy of this resource, I experimented upon rabbits, and found that a trifle of carbonate of sodium touched to the ileum of rabbits would produce intussusception in a few seconds. The danger of the production of the same effect in the ileum of man is so great, that proof of the harmlessness of sodium carbonate must be furnished before we can employ it for exciting reversed peristalsis at an abdominal operation.

The production of ileal intussusception in a rabbit gives a very pretty demonstration of the mechanism of that form of intussusception if one wishes to employ it for teaching purposes. The rabbit having been chloroformed, an incision is made in the abdominal wall, and the loop of ileum is brought out. If the barometric pressure happens to be high at the time, it is well to rest the loop of bowel on moistened cloth or paper to prevent too rapid drying of the peritoneum of the loop. If a fraction of a grain of powdered sodium carbonate is then touched to the peritoneal surface of the loop of ileum, it will be observed that in twenty or thirty seconds the circular fibres of the bowel at that point suddenly contract in tonic spasm; peristaltic movements of the longitudinal fibres of neighboring bowel then cause a slowly progressing engulfing of the portion of bowel which is in a state of spasm, and the ascending intussusception thus continues until the mass of engulfed mesentery becomes so large as to block further progress. An intussusception of about two inches of

bowel can often be obtained in five or six minutes, and it would, without doubt, remain permanently in this position, subject to inflammatory complications, but I have not allowed any rabbits to live in order to determine that point.

The mechanism of intussusception produced by the influence of sodium carbonate is the reverse of that which occurs as a post-mortem phenomenon, as I observed the latter in one case. In that case, a wave of peristalsis of the circular fibres of the segment of bowel formed a wide, lax intussuscipiens, into which the neigh-

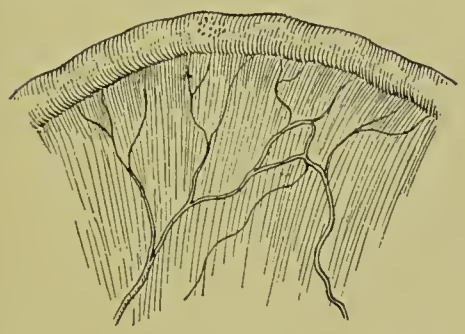

FIG. 35.—A few particles of carbonate of sodium placed upon ileum of rabbit.

FIG. 36.—Spasm of circular fibres of bowel at site of sodium carbonate.

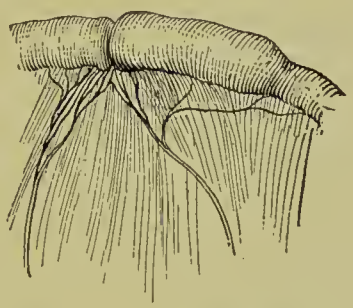

FIG. 37.—Intussusception of contracted portion of bowel.

boring segment of bowel was easily pushed for a distance of a few lines by normal peristaltic progression. Waves of peristalsis of the circular muscular coats seemed to sweep along the ileum, and several intussusceptions were on the point of forming. It is not unlikely that a few of the cases of intussusception in children may occur as a result of spasm of a portion of the bowel similar to the sodium-carbonate contraction, and caused by the toxines absorbed from the lumen of the intestine. We know that spasm of other muscles, manifested in the form of convulsions, very frequently arises from that cause in children whose intestinal contents ferment.

THE REASON WHY PATIENTS RECOVER FROM TUBERCULOSIS OF THE PERITONEUM.

We have recently learned that patients suffering from tuberculosis of the peritoneum commonly make an excellent and rapid recovery when the peritoneal cavity has been exposed through an abdominal incision. In rare instances patients also begin to suddenly recover spontaneously from tuberculosis of the peritoneum. When tuberculosis comes to a stop we presume that the tubercle bacilli have been killed, and there has been much speculation as to what could bring about that end in a class of cases in which infection was so diffuse as it usually is in the peritoneum. The following experiments were tried for the purpose of gaining a clew to the agent which proves fatal to the bacilli.

I removed several ounces of fluid from the abdominal cavity in a typical case of peritoneal tuberculosis, and exposed the fluid to the air for twenty-four hours. It was then placed in an incubator for forty-eight hours, and kept at a temperature of about 100° F. At the end of that time the fluid was swarming with saprophytes, and the toxines which they had produced were then separated from it. Small portions of the toxines proved immediately fatal to virulent test-tube cultures of tubercle bacilli, but it was thought best to subject these cultures to a further test for determining if they were capable of further development. Numbers 1, 2, 3, 4, 5, 6, 7, and 8 are used to designate the rabbits on which control experiments were made. Suspensions 1 and 2 are suspensions of tubercle bacilli in bouillon; suspensions 3 and 4 represent suspension of tubercle bacilli in the ptomaine.

July 27, 1894.—No. 1 was inoculated in the eye with a pure culture of tubercle bacilli. On the same day No. 2 was inoculated in the eye with suspension No. 1. No. 3 was inoculated with suspension No. 2. These suspensions had been in the incubator for twenty-four hours.

July 28th.—Nos. 1 and 2 seemed to suffer very little, but No. 3 was quite ill, and the infected eye was suppurating; consequently suspension No. 2 was not used again in the eye, but was injected under the skin of the abdomen. No. 4 was inoculated in the eye with No. 1 suspension, which had been in the incubator for forty-eight hours. No. 5 was inoculated on the abdomen with suspension No. 2, which had also been in the incubator for forty-eight hours.

July 30th.—Nos. 6 and 7 were inoculated like Nos. 4 and 5, respectively. Suspensions had been in the incubator for four days. As No. 1 control animal showed no specific effect from the inoculation with the pure culture, and only a small quantity of the fluid remained, the experiments were stopped to await results, and to obtain another culture of tubercle bacilli in case this culture should prove sterile.

August 4th.—No. 3 died, and the autopsy showed the cause of death to be meningitis ; no tuberculosis.

August 10th.—No. 1 died. The autopsy showed the cause of death to be coccidium ; no tuberculosis. No. 6 also died of coccidium ; no tuberculosis.

August 31st.—Another culture of tubercle bacilli was used, and suspensions 3 and 4 made like suspensions 1 and 2, respectively. No. 8 was inoculated on the abdomen with the new culture of tubercle bacilli.

September 2d.—No. 2 was inoculated for the second time, but with suspension No. 3, and No. 7 was inoculated with suspension No. 4. These suspensions had been in the incubator for forty hours.

September 4th.—No. 4 was inoculated with suspension No. 3, and No. 5 was inoculated with suspension No. 4. These suspensions had been in the incubator for four days.

September 24th.—Nos. 4 and 5 were killed, and at the site of inoculation, as well as in the lungs, numerous submiliary tubercles were found. The three remaining animals show signs of tuberculosis, but have not yet been killed. Nos. 3 and 4, however, showed that the toxines in which that lot of bacilli was suspended did not render the bacilli sterile.

It is apparent, then, that when the abdominal cavity is opened and drained, saprophytes which enter through the drainage opening produce toxines, which are fatal to, or which inhibit the growth of certain tubercle bacilli. In some cases the bacilli are not killed by the toxines, but their growth is probably inhibited for a sufficient length of time so that nuclein brought by the polynuclear leucocytes in the peritoneum can destroy them. This seems like a rational explanation for the reason why patients recover from tuberculosis of the peritoneum after operation ; but on this theory the abdomen should not be closed immediately, but should be drained in order to allow the saprophytes to enter through the drainage opening. A case of tuberculosis of the peritoneum could suddenly begin to recover spontaneously, without operation, if saprophytes were to enter the abdominal cavity through a Fallopian tube. The reason why saprophyte toxines can produce such an immediate and widespread effect upon tubercle bacilli in the peritoneal cavity is because of the character of the lymphatic circulation of

the peritoneum, such toxines being carried quickly to all parts of the peritoneum, and the polynuclear leucocytes which go to the help of the patient have very free access to all of the involved parts. In the lung, or in the knee-joint, we have no such favorable arrangement of lymphatics and capillaries, and consequently saprophyte toxines cannot reach all of the involved structures in which tubercle bacilli are growing. In some cases of peritoneal tuberculosis a change for the better occurs in the case almost immediately—sometimes within seventy-two hours, in cases in which intestines are firmly glued together, the lymphatic circulation being sufficient to carry toxines through any adherent structures. In cases in which the peritoneal surfaces have been found to be firmly united, and masses of miliary tubercle were abundant in the abdominal cavity, a glistening peritoneum, free from adhesions, has been found on subsequent operation, or on necropsy years afterward.

THE PREVENTION OF SECONDARY PERITONEAL ADHESIONS BY MEANS OF AN ARISTOL FILM.

When adherent peritoneal surfaces have been separated from each other by surgeons, there is danger of secondary adhesion as soon as the surfaces which are bare of serosa have fallen together again, and various resources have been employed for preventing such adherence. I observed that if a layer of aristol were interposed between the margins of the wound, it would sometimes present a mechanical obstacle to primary union, and it seemed probable that if aristol were applied to peritoneal adhesion surfaces, it would form a film with lymph, and that this aristol film would offer an obstacle to secondary adhesion, and give the raw surfaces an opportunity to heal separately.

A rabbit was anesthetized, and two inches of two intestinal loops were lightly scratched with a needle, and sutured together. One inch of each of the opposed surfaces was covered with a thin layer of aristol, and the other inch was left without protection. At the end of a week the rabbit was again examined, and it was found that the aristol-covered surfaces were adherent, but with such a succulent-looking mass of lymph that it was deemed advisable to experiment with other rabbits, and allow time for complete absorption of plastic exudate. Three more rabbits were treated like the first one, but with deeper scarification of the peritoneum. Loops of ileum were approximated in one, and loops of colon in the other two. The rabbit with sutured ileum died of intestinal obstruction a few days later; the other two were killed at the expiration of five weeks. In one there were close, dense adhesions at the parts that had been scarified and approximated without aristol protection, and adhesion only at suture punctures in the aristol-protected segments. Elsewhere over the aristol-protected segments there were no adhesions, but the aristol remained encapsulated in the new serosa. In the other rabbit there were loose filamentous adhesions between the unprotected surfaces, and none at all where aristol had kept the surfaces apart. In the second rabbit, as in the first one, the aristol remained

encapsulated in the new serosa. What becomes of the encapsulated aristol eventually, I do not know. It is not soluble in blood serum, but it is soluble in fat, and it is quite possible that fatty metamorphosis of surrounding tissues may in some places cause its slow solution and absorption. The experiments in rabbits were severe ones because the wounded peritoneal surfaces were held actually in apposition by sutures. In practice, the peristaltic movements of the intestines, and the shifting of movable viscera aid us in our efforts to keep aristol-protected surfaces apart.

Since the date of the preliminary experiments, I have had several opportunities for observation of the value of this resource in cases which were subjected to further operative procedures some months or years after adhesions had been prevented from re-forming. We cannot obtain an aristol film on deeply seated adhesion surfaces if blood serum or peritoneal fluid wash away the aristol before it has become fixed with lymph, but as half a minute will answer for this purpose—a minute is better,—the film can be formed on surfaces which can be well dried with a sponge or gauze, and exposed to the air for that length of time. The pedicle of an ovarian tumor, or any tissue bared of peritoneum, will not form troublesome adhesion to the bowel if protection is given by forming a lymph-aristol film upon such raw surfaces.

ANOTHER METHOD FOR PALPATION OF THE KIDNEY.

ISRAEL finds a kidney by placing the patient upon her back with flexed legs, and then while one hand makes pressure over the lumbar region of the patient, the tips of the outstretched fingers of the examiner's other hand are placed just below the costal cartilages, and on a line which runs from the middle of Poupart's ligament parallel with the median line of the abdomen. Then, with each expiratory movement on the part of the patient, the fingers are pressed deeper and deeper down toward the kidney, and the impression left upon the finger tips at each step of progress is kept well in mind. When the lower end of the kidney is felt, the patient is instructed to take a deep breath, and force the kidney out under the fingers of the examiner. Guyon palpates in very much the same way, but introduces a new feature, which consists in making quick, forcible pressure with the fingers in the lumbar region, thereby causing a spasmodic contraction of the quadratus lumborum muscle, which lifts the kidney up toward the examining hand. When the patient is in a supine position, there is sometimes an obstacle to good palpation of the kidney in the presence of interposed omentum and intestine or stomach. A lobe of liver will sometimes be forced under the finger, and simulate kidney very closely unless one is careful to first make out the sharp edge of the liver, and then be sure that the fingers are well under it.

In placing patients in various positions for the purpose of examining loose kidneys, I have found one position that is often very satisfactory. If the right kidney is to be palpated, the patient lies upon her left side with the legs flexed so that the abdominal muscles are relaxed, and the intestines and omentum sag toward the table side of the patient. If the kidney is loose, it then slides out in such a way that it becomes the highest round body found beneath the abdominal wall at a certain point. The intestines and omentum are out of the way, and the kidney has moved between peritoneal planes, or has swung upon a mesonephron into a position to be easily examined. The certain

point at which the kidney is found is somewhere in the cavity that forms along the margin of the right quadratus lumborum muscle when the abdominal viscera sag towards the table. Different patients require somewhat different positions of the limbs, and different angles with the top of the examining table, in order that the point of greatest degree of relaxation of the abdominal wall be obtained. A very fleshy patient, for instance, may have to be rolled almost into a prone position because the weight of the viscera must be partly borne by the table before the tension of the abdominal wall is relieved. If a loose kidney does not at once slide out of the normal position when the patient is properly placed, a blow upon the lumbar region with the hand will displace it, and we can then obtain a more resonant percussion note over the site that the kidney formerly occupied. With some patients in the position described I have been enabled to hold the entire kidney in one hand almost as easily as if it were a potato in a bag.

For examining kidneys that are not loose, I still prefer to examine according to the method of Israel, or of Guyon. A great many patients who are at present being treated for obscure disease of the pelvic organs, and for all sorts of abdominal distress, will be found to have a loose kidney, if a satisfactory method for palpation of the kidney is employed. The real proportion of loose kidneys is not determined in ordinary post-mortem examinations because a kidney which would slip between the peritoneal planes almost to the pelvis, may glide back into place and become fixed by rigor mortis, or remain in place simply by its own weight, with the subject in the recumbent position.

True floating kidney with a meso-nephron is of rare occurrence, but loose kidneys are very common. The right kidney is the one that usually wanders, presumably because corsets which fix the lower costal border prevent the liver from gliding forward on inspiration, and the liver then must move up and down like a piston, forcing the kidney away from its connective-tissue bed. A retroverted uterus may sometimes cause enough tension of the short right ureter to start a kidney out of its bed. There are many common causes for a kidney leaving its connective-tissue anchorage, and once it is loosened, gravitation increases the range of the wandering.

Some years ago I prophesied that loose kidneys would form the next subject for general widespread interest in the medical profession, but appendicitis and anti-toxines have come forward first.

EXPERIMENTS GERMANE TO THE SUBJECT OF ABDOMINAL SUPPORTERS AFTER LAPAROTOMY.

An abdominal incision about two inches in length was made in the middle abdominal line in a series of adult rabbits, and the incision was closed with catgut in two tiers. The first tier included peritoneum, muscle, and fibrous planes; the second tier included skin. The method of examining the character of repaired tissues afterward, consisted in dividing up the abdominal walls into strips, half an inch wide, cut transversely across the abdomen after the rabbits had been killed with chloroform. The strips were then dissected in such a way that skin was separated from muscles and muscles from peritoneum. It was not possible to separate the peritoneum nicely in rabbits because of its close connection with the abdominal wall. The fresh strips were kept in saline solution while the experiments were being made. The testing apparatus consisted of a pair of screw clamps and a spring balance registering pounds up to fifty. One end of the strip of tissue was fastened between blocks of wood to prevent slipping, and the clamps were then screwed down upon it. The other end being treated in the same way, the spring balance was hooked to one clamp, and traction was made on the other, while the indicator was watched.

First rabbit—three days after operation. A strip of unwounded abdominal wall, half an inch wide and three inches long, was first tested. The skin pulled apart with a traction of eighteen pounds. (In all of these experiments the pounds are given in round numbers.) The strip of muscle and fascia pulled apart at sixteen pounds; the peritoneum containing a little muscular tissue from the abdominal wall, at seven pounds.

Sutured structures removed—no tissue bore a pull of one pound.

Second rabbit—killed seven days after operation. The peritoneum was injured in trying to dissect it away for experiment.

Third rabbit—killed seven days after operation. The peritoneum could be dissected away fairly well by first pinching it up between the fingers, but some muscular fibres remained attached. *All sutures removed.*

Normal peritoneum tore at eight pounds.

Sutured peritoneum tore at eight pounds.

Normal muscle wall tore at fourteen pounds.

Sutured line in muscle wall tore at five pounds.

Normal skin tore at seventeen pounds.

Sutured skin tore at two pounds.

Fourth rabbit, killed ten days after operation.

The peritoneum was not tested as it was evidently perfectly repaired.

The muscle gave way at stitch holes, but the tear extended into normal muscle, as well as into wound line.

The skin tore through wound line.

Fifth rabbit, killed fourteen days after operation.

The sutured peritoneum was normal.

Muscle and fibrous structures did not tear along the wound line more readily than in normal tissue. The fibres slid apart, as threads slide in woven material which is subject to tension, in normal tissues and in the vicinity of the wound alike.

The skin gave way in the wound line still, but sliding of the fibres instead of direct tearing began at this date.

Sixth rabbit, killed eighteen days after operation.

All repaired structures were found to be as strong as normal ones, but the tears beginning anywhere near the wound line always ran to a stitch depression, or else began there and ran to near tissues.

Seventh rabbit, killed at twenty-one days.

Eighth rabbit, killed at thirty-eight days.

The same observations were made on these as in the sixth rabbit.

In practice I have not to my knowledge had ventral hernia follow operation in wounds which were closed at the time of operation with or without a drain. This includes several hundred laparotomies for all sorts of conditions requiring abdominal operation. The only patients whom I know to be wearing abdominal supporters to-day are two who had general suppurative peritonitis and whose wounds had to be left widely opened, one who came into my hands as a ventral hernia case, and a fourth whose abdominal wall feels weak from local paralysis of muscles near the incision, but who has no hernia. If any other patients of mine are wearing abdominal supporters or trusses of any sort for post-operative hernia I would like to be apprised of the fact, for quotation in a later edition. As a rule, patients were allowed to get out of bed on the seventeenth day after operation, and no abdominal supporters have been applied afterward excepting in the four cases mentioned, although a common abdominal bandage for general support has sometimes been kept on by the patients for a short time after getting out of bed. Abdominal supporters seem to be unnecessary if the abdominal structures have been well sutured, but if suturing has not been done accurately, abdominal supporters I believe are useless for the prevention of hernia. I have always made it a rule to suture structures separately

and with the utmost degree of precision, feeling that *in that way only could structures be left as they were found.* Silk or silver wire have never been used for closing my abdominal wounds. Silk-worm gut was employed in perhaps twenty cases. Kangaroo tendon was tried satisfactorily in a few, but small chromic catgut was used for the hundreds. Of late years my sutures have not been passed through the adipose layer of abdominal walls, as the fatty layers are perfectly approximated by atmospheric pressure after the deeper tissues and skin have been accurately sutured with fine catgut.

AN ADDITION TO McGUIRE'S OPERATION FOR A SUPRA-PUBIC URETHRA.

In only one case has there been occasion to try the following resource, because patients with hypertrophy of the prostate gland under careful palliative treatment and management do not often require surgical operation.

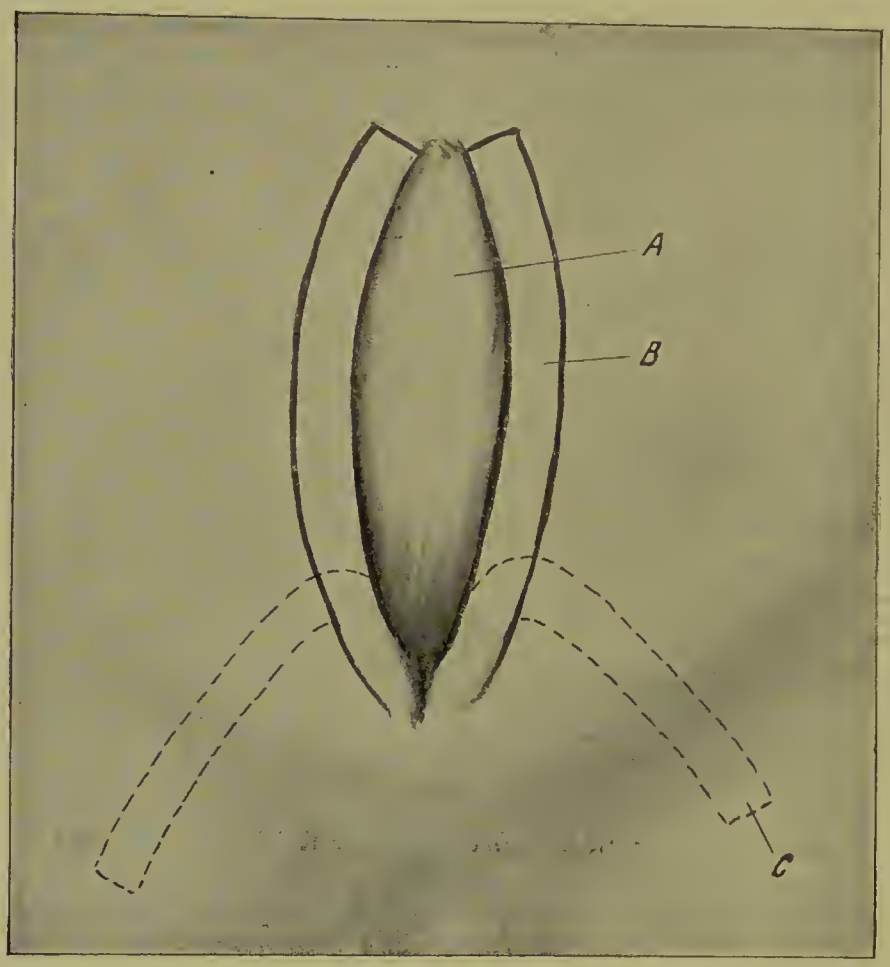

Fig. 38.—A. Rectus abdominis muscles.
B. Skin flaps outlined.
C. Skin flaps dissected from attachments and turned down.

This patient, sixty years old, could not be relieved by the resources which were faithfully applied, and he was suffering from chronic septi-

cemia from an aggravated suppurative cystitis. He could not pass a catheter or empty the bladder completely without a catheter. His prostate gland was large and irregularly hypertrophied. An incision four inches long, was made in the middle abdominal line, ending at the pubes. Then an incision was made on either side of the mid-line incision, making two strips of skin which were to be employed later for forming a supra-pubic urethra. The bladder was brought up to the opening in the abdominal wall, and held temporarily with sutures. As in the Hunter McGuire operation, the bladder was then opened at the lowest anterior point. The strips of skin together with

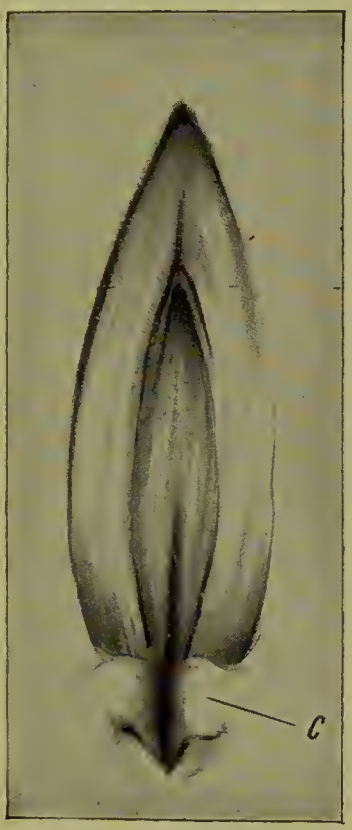

FIG. 39.—C. Skin flaps turned in and sutured to bladder.

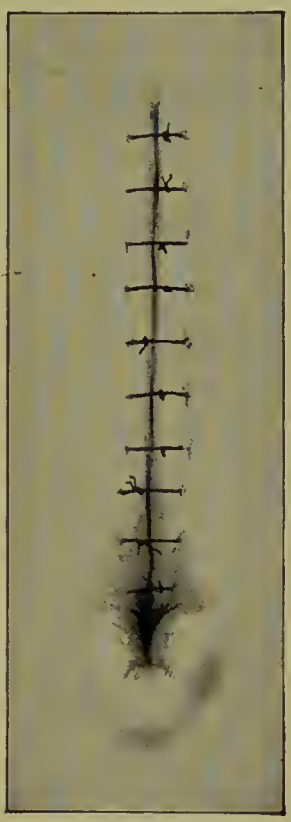

FIG. 40.—Wound closed and fistula formed.

fat and subcutaneous tissue were dissected away from either side of the mid-line incision, leaving them attached at their distal ends. These strips were about one third of an inch broad. Their free ends were sutured with fine catgut to the mucosa of the bladder, each strip on its respective side. The temporary sutures which held the bladder against the abdominal wall were cut, and when the bladder dropped back, it took with it the two ribbons which had been sutured to the mucosa of the bladder and which then lay face to face with the cutane-

ous surfaces in apposition. That made a fistula lined with skin, reaching from the mucosa of the bladder to the skin of the abdomen. Aristol was rubbed into the wound to prevent infiltration of urine, and a drainage wick with one end in the bladder and the other at the abdominal surface drained off urine while the process of repair was going on. Four weeks after the operation the wounds had entirely healed. The patient could then hold his urine for three hours, and pass it at will, using a glass tube to press against the abdominal wall to guide the urine away from his clothing. An ordinary expulsive effort was sufficient to empty the bladder by way of this fistula, and no urine passed through the penis.

One year after the operation the patient could still hold his urine for three hours, but there was a trifle of moisture about the opening most of the time. Two years later, there was a still greater leakage of urine, although the patient was able to carry on all of his work as a farmer. The reason why the later trouble occurred was because the walls of the fistula were rather rigid, the strips of skin having contracted to form a firm, round canal. In another and similiar operation, I would make the strips more than half an inch wide in order to obtain a supra-pubic urethra with walls which would remain soft enough to keep them in apposition.

THE DRAINAGE WICK.

THE application of the principle of capillary drainage for wounds is potent for good if applied in full knowledge of the mechanical features of this resource, and potent for evil if applied wrongly. An illustration of its uselessness is observed if we place one end of the strip of absorbent gauze in the uterus, and leave the other end folded up in the vagina; but if the end of gauze in the vagina is brought outside and allowed to rest in a mass of absorbent gauze, capillary drainage proceeds usefully and at once, until the mass of gauze becomes saturated with serum, when capillary power again decreases, and stops. A very large gauze drain or gauze packing in the abdominal cavity is potent or impotent relatively with its size as compared with that of a mass of absorbent gauze with which it is in contact upon the abdominal wall. The larger the mass of gauze within the abdominal cavity, and the smaller the mass on the outer wall, the less effective is the drainage. A large mass upon the outer wall ceases action when it becomes saturated with fluid. A mass of gauze within the abdominal cavity is soon filled in its meshes with coagulated lymph, and its capillary action ceases. The lymph unites gauze and tissues together and repair begins, Nature attempting to encapsulate the gauze. Then, when the gauze is removed, the tissues are rudely disturbed, and the excess of reparative lymph which has been thrown out makes an inviting field for bacteria. Repair cannot proceed until the excess of lymph has become absorbed or has broken down. Gauze is rendered still less useful if loaded with iodoform and fixing agents.

In order to obtain the full benefit of capillary gauze drainage, and employ a small "drawing column" of absorbent gauze for the interior of the wound, a large "receiving mass" of absorbent gauze must be placed in contact with it, lying outside of the wound. The mass of receiving gauze must be changed when it becomes saturated to the point of decreased power, otherwise it will have little mechanical effect upon the column of drawing gauze within. Reparative lymph is prevented from encapsulating

the drawing column of gauze, which I call "the wick," by surrounding it with gutta-percha tissue or Lister's protective oiled silk. This also prevents disturbance of the tissues when the wick is removed, as union does not take place between the tissues and the waterproof material. The wick is made of a strip of absorbent gauze not much larger round than a lead-pencil for most purposes, and this strip of gauze is rolled in gutta-percha tissue very much as one would roll a cigarette. Such a wick could draw quarts of serum or blood out of the abdominal cavity, and it forces opposed peritoneal planes at a distance to act by capillarity from all parts of the abdominal cavity toward the point at which the greatest capillary power is being exerted. Little holes are snipped through the gutta-percha covering of the wick after it has been rolled, so that the fluids can enter at more than one point, but

FIG. 41.—Drainage wick.

the holes are not large enough to allow tissues to become adherent to the gauze within the waterproof material. The wick is not used for more than thirty hours, as a rule, in the abdominal cavity, for adhesions may be expected to wall off any sort of drainage apparatus in the peritoneal cavity by the end of that time. If further drainage is necessary, I carry a narrow strip of gutta-percha tissue into the wound, and then allow the pressure of the tissues to force fluids along the line of least resistance, which is along the strip of gutta-percha tissue. The gauze in the wick must be rolled loosely. A wick long enough to rest behind the uterus will adjust itself to curves so nicely, and will be so soft, that no shock is caused by its presence. After removing the drainage wick from a wound, balsam of Peru is generally injected into the sinus for a few days, and a final injection of iodoform and glycerine in the proportion of one part to seven is very efficient.

ENDOSCOPIC TUBES FOR DIRECT INSPECTION OF THE INTERIOR OF THE BLADDER AND UTERUS.

For direct inspection of the interior of the uterus in women, and of the urinary bladder in both sexes, I use a straight tube of thin silver-plated brass. A central stilette, which is removable, carries the obturator and the handle. Two centimetres of the handle end of the tube are belled to become twice the diameter of the rest of the tube. The tubes for the uterus and for the bladder in women are 9 *mm.* and 13 *mm.* in diameter, respectively.

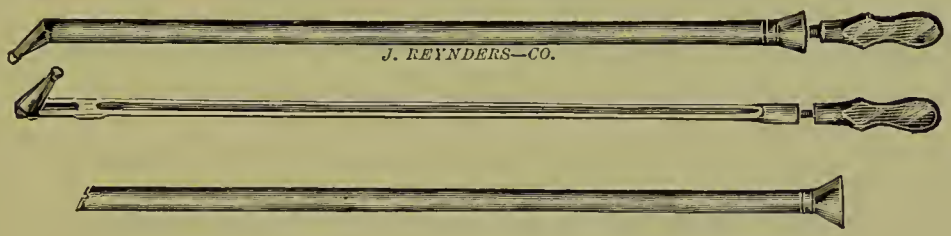

Fig. 42.—Endoscopic tube for examining male bladder.

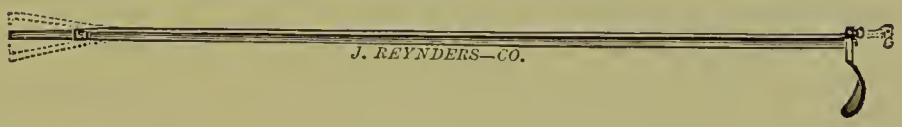

Fig. 43.—Forceps for introducing catheter or removing small objects from the bladder.

Fig. 44.—Flexible rectal elevator for manipulating walls of bladder.

The length, exclusive of plug and stilette, is 13 *ctm.* The tubes for inspection of the male bladder are of the same respective diameters, but of the length of 24 *ctm.* exclusive of handle and obturator. It is usually necessary in examining the male bladder with the large tube to first nick the meatus and pass a sound.

The tubes for the examination of the uterus and the bladder in the female are furnished with a simple plug obturator, but for the examination of the male bladder a dilatable obturator is used in order to fit the shoulder of the entering end of the tube, and thus

make an even surface which will not catch the urethra at curves. The obturator is dilated by turning the screw handle, which pushes a wedge rod, between the wings of which the obturator is composed. The obturator is composed of two sets of wings, surmounted by a removable knob. When the instrument is to be cleansed, the knob is unscrewed, the two sets of wings are pulled apart, and each separate wing is unjointed from its fixation pin. Straight tubes which have been invented for examination of the male bladder have been too small, and the obturators have been difficult to cleanse. The tube which I use does away with these objections. Formerly I examined the bladder with the patient in the supine position, but in a position which allowed the bladder to contract, and this gave a field of view equal to the diameter of the tube only, so that it was often a laborious process to find the openings of the ureters or to examine any definite part of the bladder. It was necessary to insert an elevator into the rectum to lift the trigone of the male bladder into view, and the elevator must still be used for that purpose where the finger in the rectum will not answer the purpose.

Kelly, of Baltimore, gave us the greatest step in progress of the examination of the bladder through straight tubes, in a paper published in the *American Journal of Obstetrics* in 1894. Since the publication of that paper I have adopted his plan of elevating the hips of the patient until the intestines cease to make pressure against the bladder, and when the tube is then inserted, the bladder becomes more or less dilated with air, and gives us an excellent view of its walls. It is now, by Kelly's technique, an easy matter to find the openings of the ureters in women, but in men, unless the bladder at the opening of the ureter is inflamed, we cannot find it until a little gush of urine marks the spot. As the ureter empties itself by a quick contraction at short intervals, however, the accumulated drops of urine which are forced out can be easily seen. Another reason why it is more difficult to find the ureters in men than in women is because the tube cannot be moved through as great a range of motion, being limited by the triangular ligament and the prostate gland.

A suction apparatus, consisting of a syringe fitted with a small rubber tube, somewhat longer than the ordinary catheter, serves to empty the bladder of urine which collects while an examination is being made. A very long and slender pair of slide forceps is useful for carrying a catheter or a whalebone bougie into the

ureter, or for removing any small object, or specimens snipped from the wall of the bladder.

In proceeding to examine the interior of the uterus, the cervical canal is first dilated with any proper instrument. The uterus is then brought down and steadied with volsella forceps in cases in which that can be harmlessly done, and the tube is entered to the fundus. The obturator is removed, and with a head-mirror light is thrown through the endoscope. By turning the endoscope properly, the openings of the oviducts can be readily inspected, and then on slowly withdrawing the endoscope, the whole of the interior of the uterus is examined. In examining the interior of the bladder in men with light reflected from a head-mirror, it is necessary to have a stronger light than that required for the female bladder or uterus on account of the length of the tube. Actual sunlight is by all means the best, and when it is possible to do so, I ask male patients to wait for a clear, sunny day for their examination. The endoscopes are practical for all common diagnostic purposes for which they are intended, although for examination of the male bladder in certain cases the Nitze cystoscope in the hands of a few experts is superior.

THE ACTION OF TRYPSIN, PANCREATIC EXTRACT, AND PEPSIN, UPON SLOUGHS AND COAGULA.

Masses of putrescible material which must be removed by the surgeon sometimes require an extensive operative procedure unless such masses can be liquefied and washed away. A large psoas abscess may have upon the walls of its cavity a half pound of tenacious, partially organized lymph coagula which cannot be removed easily with the curette and spoon, but which will putrefy and cause dangerous septicemia if allowed to remain after the abscess has been opened. In some cases of empyema, or of traumatic pleurisy, large masses of lymph form bands and diaphragms within the chest cavity, and loose masses of coagula, which are too large to escape through the surgeon's incision, remain behind to decompose. The bladder is sometimes filled with blood clot. Sloughs which are undergoing decomposition, but which cannot be peeled away from a wound, may require removal by operation to prevent septic complications. In all of these cases the masses of putrescible material can be liquefied promptly and harmlessly if a digestive ferment can be properly applied to them.

The necessity for such a resource first came to me in a case of crushed liver resulting from a violent horse kick. A large part of the liver seemed to have been destroyed by the blow, and an abscess cavity filled with several quarts of blood and thin brownish pus had quickly formed, but was walled in with peritoneal exudate. A long incision below the right costal border evacuated the abscess contents, and disclosed black and sloughing masses of crushed liver, which I tried to excise, but with the production of such alarming hemorrhage that it was impossible to proceed. Pultaceous lymph coagula were attached to the walls of the cavity in places, and fibrinous blood coagula formed stringy bridges across the lacerated structures.

Into this unpromising wound we injected an acidulated solution of pepsin, which was washed out with hydrogen dioxide about two hours later. The process was then repeated at intervals during a period of forty-eight hours, by the family physician, who reported at the end of that time that the last of the sloughs and coagula had become liquefied and had passed out of the wound in the form of a voluminous, treacly fluid, brownish at first and finally straw-colored. The cleansed cavity rapidly contracted, and the patient made an excellent recovery.

After experience with this case experiments were tried with different digestive ferments. On theoretical grounds I had supposed that trypsin would be the best liquefier, that pancreatic extract would stand next in value, and that pepsin would be used only when it was inconvenient to obtain other ferments ; but in the practical tests pepsin proved to be the most efficient. It is not necessary to actually digest the substances which are to be removed, as liquefaction of the masses is all that the surgeon requires of the ferment. For test purposes, tough, partially dried coagula from beef's blood were employed, and the trypsin, pancreatic extract, and pepsin were obtained fresh from the works of Fairchild Brothers & Foster. As a result of several experiments, it was determined that four grammes of pepsin dissolved in three hundred cubic centimetres of water acidulated with one per cent. of hydrochloric acid and applied to one hundred grammes of the coagula at a temperature of about 100° F., would liquefy the coagula in thirty-six minutes. Pancreatic extract in alkaline solution, with proportions and conditions as in the pepsin experiment, required one hundred and forty-six minutes for liquefying the coagula, and some small knots of fibrin remained even then. Trypsin in alkaline solution, used with proportions and conditions as in the pepsin experiment, required one hundred and thirty minutes for liquefying the one hundred grammes of coagula. Two grammes of tough lining membrane from the cavity of a coxitis abscess were liquefied in fifty-five minutes with the pepsin solution.

Since these tests were made, I have had occasion to employ pepsin solution for various surgical conditions, and have determined that there are some precautions to be observed. The pepsin solution used in the vicinity of new scar tissue will dissolve it, and cause the wound to gape. It will also liquefy catgut sutures and ligatures. Although pepsin attacks dead tissue rapidly, it does not seem to exert a harmful influence on tissues in which blood is circulating. Thus, the stomach walls do not digest while the tissues are normal and living ; but if an ulcer of the stomach causes a sufficient degree of exudation anemia at any one point, a perforation of the stomach may be caused by the digestion of the anemic spot. A very good illustration of the action of digestion of tissues is furnished in trout which have been caught on a warm day, particularly when the stomach has been torn by a swallowed hook. In such a trout the viscera are found to be partially liquefied when the trout are dressed a few hours later.

A thick solution of pepsin is not so effective as a thin, watery solution, for pepsin normally requires a good deal of water for its best action. The proportions of the solutions for surgical purposes are as follows : Distilled water, four fluid ounces ; hydrochloric acid, U.S.P., sixteen minims ; best scale pepsin, half a drachm.

The glycerine extract of pepsin, and papoid, have been recently recommended as particularly good preparations for the surgeon's use ; the papoid because it can be sterilized without destroying its efficiency, and because it is active in both acid and alkaline media, but I have had no opportunity to make accurate tests with anything excepting the digestive ferments as described.

After liquefying sloughs and coagula, I usually cleanse the wound with hydrogen dioxide, and then stimulate the tissues to the formation of granulations with balsam of Peru ; but after the removal of clots from the bladder, special cleansing is unnecessary.

THE REMOVAL OF NECROTIC AND CARIOUS BONE WITH HYDROCHLORIC ACID AND PEPSIN.

Sometimes it is desirable to remove dead bone without subjecting the patient to an extensive operation. Attempts have been made with some success at clearing out this bone by a process of decalcification, but there was one chief reason why failures have resulted. It was discovered that superficial layers of dead bone were decalcified easily enough, but the acids did not reach deeply into the mass, especially if portions were infiltrated with caseous or fatty debris. After much experimentation, I have adopted a method of work which is satisfactory in selected cases.

An opening is made through the soft parts, if necessary, by means of a direct incision to the seat of dead bone, and if many sinuses are present they are led, if possible, into one large sinus. The large direct sinus is kept open with strips of gauze soaked in balsam of Peru, and the wound is allowed to remain quiet until granulation tissue is well formed. The next step consists in injecting into the sinus a three per cent. solution of hydrochloric acid in distilled water. If the patient is confined to bed, the injections can be made at intervals of two hours during the day ; but if it is best to keep the patient out of bed, the acid solution is thrown into the sinus less frequently, and the patient in either case must assume a position favorable for the retention of the solution. Decalcification of exposed layers of dead bone takes place in a few hours, and then comes the necessity for another and very important step in the progress. At intervals of about two days an acidulated pepsin solution is thrown into the sinus (distilled water, four ounces ; hydrochloric acid, U.S.P., sixteen minims ; scale pepsin, half a drachm). This solution will liquefy decalcified bone and caseous and fatty debris in less than two hours, leaving clean dead bone exposed for a repetition of the treatment. The treatment is continued until the sinus closes at the bottom, showing that the dead bone is all out ; but in progressing cases of tuberculosis, it is advantageous to throw into the sinus at intervals of a week, a ten per cent. mixture of iodoform in glycerine, allowing this mixture to remain in place for twenty-four hours. In tortuous channels which will not receive the thick glycerine mixture, a seven per cent. ethereal solution of iodoform may be used in its place. In tuberculous cases, apparatus for immobilizing diseased parts, and

tonic constitutional treatment are necessary in conjunction with the treatment for the removal of dead bone. If a cavity in which we are at work is suppurating freely, it should be cleansed with boiled water before medicated injections are employed.

It is a popular impression that living bone is not attacked by very dilute solutions of mineral acids. In order to test this point I made the following experiments: A portion of the keratinoid layer was removed from the carapace of a live turtle (*Nanemys guttatus*), and the animal was then placed, tail downward, in a glass of five per cent. hy-

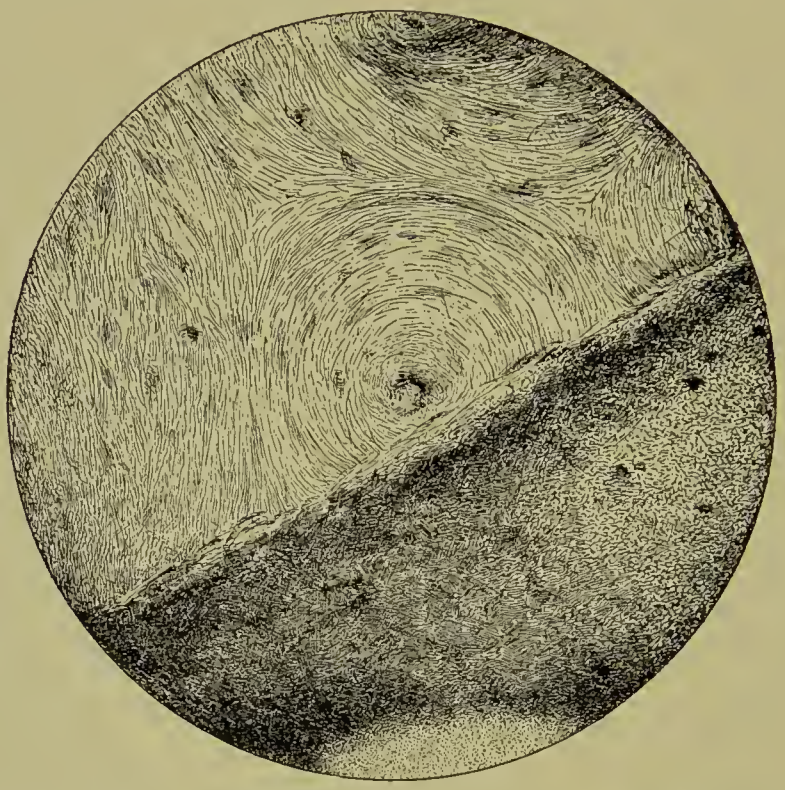

FIG. 45.—Dark portion, decalcified bone, which is stained with carmine up to the light portion, living bone.

drochloric acid solution. In the same glass I placed a segment snipped from the plastron of the turtle, and also a thin transverse segment from an old, dry humerus from a man. The piece of humerus was decalcified in six hours; the piece of plastron was distinctly softened in twenty hours, and the submerged portion of the exposed living carapace was decalcified in thirty hours. I was then curious to note what effect the acid had produced on the carapace, and sections for microscopical examinations were made, which included both decalcified and normal bone. These sections were stained with carmine. Investigation showed that all of the blood-vessels were destroyed wherever the bone

was softened, and the action of the acid had extended farther along the line of the larger blood-vessels than elsewhere.

In the accompanying photo-micrographs taken from these slides, the dark portions show decalcified bone stained with carmine, and in the lighter portions normal bone is distinguished. In Figure 46 can be seen the line of extension of decalcification along the course of three blood-vessels. The difference in time required for decalcification of the dead bone (six hours) and of the living bone (thirty hours) is significant, a five per cent. solution having been used. If we use a three per cent.

FIG. 46.—Dark lines showing decalcification along lines of blood-vessels, carmine stain.

solution of hydrochloric acid in practice, a wall of granulation surface is thrown out upon the surface of living bone so that dead bone only undergoes destruction, according to my observation in several cases in which the results of treatment could be watched.

This plan of treatment is not to be depended upon for progressing cases of tuberculosis or osteo-myelitis of the bones, but sometimes it works beautifully in such cases. Its principal field for usefulness is in cases which are not progressing and in which dead bone has been left behind as the result of any destructive process.

IS EVOLUTION TRYING TO DO AWAY WITH THE CLITORIS?

During a period of twelve months I collected statistics from some three hundred cases, which showed that about eighty per cent. of Aryan-American women possess preputial adhesions, which bind together the glans of the clitoris and its prepuce. The condition evidently represents a degenerative process that goes with higher civilization. It dates back to the embryonic life of the individual, and consists anatomically in

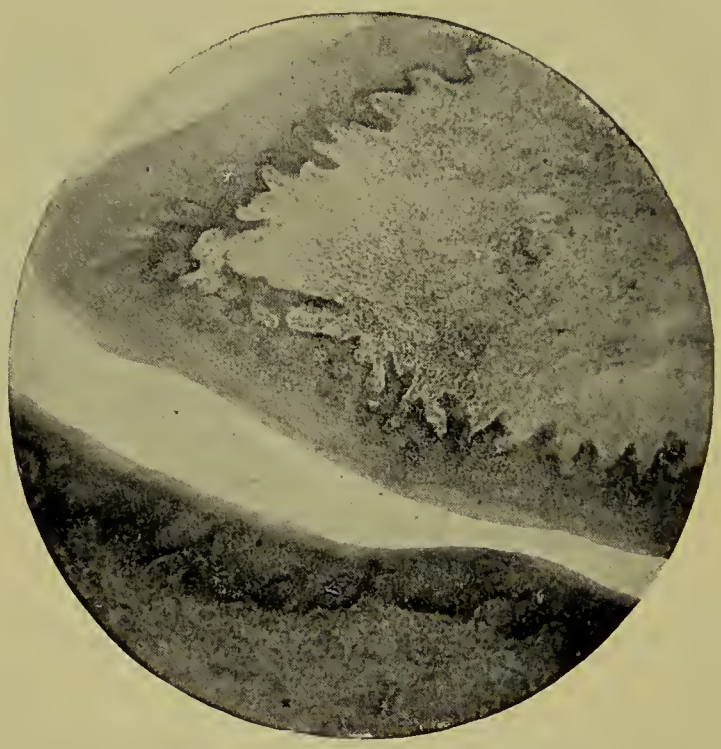

Fig. 47.—Section of apex of normal *glans clitoridis*, and prepuce.

a failure of the genital eminence to develop its epithelial surfaces perfectly enough for complete cleavage between the opposed surfaces of the prepuce and glans of the clitoris. This degeneration sign is as well marked as those furnished by poorly developed mammary glands, early falling hair, and teeth which are prone to decay.

Preputial adhesions in women are similar in character to those which occur less frequently in men, and the resulting disturbances are alike

in both sexes, but greater in degree in women because of the more impressionable nervous system of that sex. Adhesions may bind down the prepuce so closely that no part of the *glans clitoridis* is in sight. They may involve half of the glans, or they may form only a small adherence which is of no importance excepting as an anatomical curiosity. This curiosity is serious, is portent, however, for Nature in failing persistently to develop the part indicates that it is intended that the clitoris is to disappear as civilization advances. The adherent prepuce is important not only as a degeneration sign, but in children and in young women it sometimes produces such an impression upon the

FIG. 48.—Section of adherent *glans clitoridis* and prepuce. Dark line of adhesion.

nerve centres that the whole sexual apparatus is influenced toward degeneration—a result, rather than a coincidence, in at least some of the observed cases which recovered from the beginning degeneration of the uterus and adnexa after circumcision had been performed. The *glans clitoridis* confined among adhesions, fails to develop, and remains small and compressed. The glands of the mucous membrane of the prepuce also fail to develop at the points of adhesion. It is a remarkable fact, however, that when adhesions have been separated, and the prepuce prevented from re-adhering to the glans of the clitoris, the glans will in a few weeks develop to what is apparently a normal size. The glands of the mucous membrane at the same time become perfect,

as determined from typical specimens removed for examination, furnishing abundant normal secretion ; and these restorative changes take place even after years of repression. I know of nothing analogous among the higher vertebrata.

There were ten negresses among the patients examined, and preputial adhesions were found in three who very likely possessed an admixture of Caucasian blood. In the others, the glans and prepuce were perfectly developed. A number of highly domesticated animals were examined for me by Professor James Law, who stated that in them the *glans clitoridis* was free, and the prepuce not adherent, excepting as the

FIG. 49.—Space for encapsulated smegma in adhesion line.

occasional result of parturition injury. A large number of Semitic women among the patients showed very little tendency to preputial adhesions, and the glans and prepuce were in them usually as well developed as were their mammary glands. This fact is extremely interesting, as compared with the great proportion of clitoris and mammary degeneration signs in Aryan American women, and would indicate that the Semitic people are to outlast us.

Some of the phenomena of physical degeneration of civilized races are of interest only as evidences of retrogression, but preputial adhesions in children and young women are malevolent in influence when they involve much of the glans of the clitoris. The disturbance caused by preputial adhesions depends primarily upon irritation of the terminal

branches of the pudic nerve in the attempt of the erectile *glans clitoridis* to adjust itself to the less elastic prepuce; and it depends secondarily upon the irritation caused by retained secretions. The retained smegma is usually found in the form of small, white inspissated particles, but sometimes a small area of developed glands secrete enough to cause tension among the adhesions, and when retained smegma happens to become transformed into an acrid, thin fluid, it finds a point for gradual escape, and causes pruritus or even excoriations about the vulva. Some of the cases of suppurating vulvitis in children begin at such small excoriations about the prepuce, in which local inflammation is caused by retained smegma, but these are not so common or so important as the ones of simple irritation from incarceration of the erectile *glans clitoridis*. The irritation of preputial adhesions early attracts the attention of the child to that part, which is frequently rubbed to give relief, until the habit often becomes a fixed one—innocently on her part—as the girl grows older, and neurasthenia results. Any one who has previously had no occasion to make inquiries of girls who suffer from adherent prepuces will be surprised at the answers to his inquiries relative to the frequency with which they feel impelled to rub the irritable region. The subject needs the immediate and direct attention on the part of every woman physician in the country to-day.

After collecting enough cases for statistical purposes, I dropped the subject, as it is naturally repelling to one of the opposite sex, but the proper persons must at once take up this work of looking after adherent prepuces in young girls. In making inquiries of the patient it is well to state that signs of local irritation are discovered, and then the patient, knowing that we have a clue, will freely state what she otherwise might deny.

As a result of continued adhesion irritation, or of neurasthenia from the effect of rubbing, a second series of disturbances appears—the reflex neuroses, and in this group of symptoms we have the most complicated and the most harmful of the influences emerging from the peripheral irritation at the clitoris. Chronic peripheral over-stimulation of the centripetal nerves connected with the centres of the spinal cord and brain lead in ordinary concatenation (1) to the common acute reflex demonstrations; (2) to slow degenerative changes in organs the functions of which have been disturbed; and (3) to complications dependent upon such degenerations. For instance, if preputial irritation neurasthenia leads to relaxation of the uterine ligaments, and the resulting malposition of the uterus leads to degeneration of the ovaries, the patient may suffer more from the ovarian complication than from the original cause for that complication, but the removal of the ovaries will not make her well. The fast growing girl with preputial adhesions

may become languid enough to sag into scoliosis, and no amount of orthopedic treatment will stop the scoliosis, which is but a symptom in her case. The young asthmatic, the girl whose uterus is anteflexed, the child who is listless and fretful and fanciful as to her food, the patient with enuresis or with dysuria, and with menstrual irregularities, the hysteric, the patient with epileptoid convulsions, the patient with nervous dyspepsia or spasmodic stricture of the œsophagus, or non-inflammatory paralyses of the legs—all of these must be examined by the diagnostician for preputial adhesions. I do not wish to be understood as underrating the importance of any of the other well known causes for the same symptoms—errors of refraction perhaps standing first in causal relation for many of them,—but would simply state that preputial adhesions are the prime factor in a sufficient proportion of the cases to at least make it necessary for us to eliminate that factor whenever it is found.

Before neurotic habits have become established, the symptoms which are dependent upon preputial adhesions will often disappear as quickly as does sciatica that is dependent upon Dupuytren's contraction of the palmar fascia, or the cough which is dependent upon a bean in the ear, when the cause is removed. With older patients in whom neurotic habits have become established, the results are not so immediate or so well marked as in children. In few patients beyond the age of twenty-five years is very much gained by the separation of preputial adhesions, although chronic local irritation may be stopped and some unresponsive wives find that the clitoris was at fault. The proper time for the separation of preputial adhesions is when the babe is first born, and as a matter of routine practice. Baker Brown, I believe, was very near to the subject of preputial adhesions when he published his work on *The Curability of Various Forms of Insanity, Epilepsy, Catalepsy, and Hysteria*, but his method consisted, not in the separation of adhesions, but in the bodily removal of the offending clitoris, and he ignored as much physiology as is ignored by many other observers who find revelations along a new line of investigation, and who try to leaven too big a lump with their findings.

Some of the results of separating preputial adhesions are so striking that one finds it hard to avoid giving too much importance to the subject as a whole. One of my patients who suffered from epileptoid seizures, with several attacks weekly, simulating *grand mal*, is reported by the family physician as having had no attacks for a year since circumcision was performed on her. In another case, with a separation of adhesions without circumcision, there was a tendency to re-adhesion. The patient was free from epileptoid convulsions when the prepuce was free, but suffered from such attacks when the prepuce became

re-adherent. Medication was discontinued at the time in both cases, and not resorted to while they were under observation. Nocturnal enuresis was promptly stopped in several of my patients by separation of preputial adhesions from the *glans clitoridis.* Very many neurasthenic girls made prompt and striking improvement as the result of the same treatment. In a word, I may say that separation of preputial adhesions in girls accomplishes just what it does in boys, plus relief from such uterine and ovarian complications as are dependent upon that cause, and they are not few.

After separation of preputial adhesions, there is a marked tendency for them to recur, and excepting in infants, I now advocate the removal of the prepuce instead of simply separating it from the glans. The work can be done under cocaine, if cocaine is injected hypodermatically into the glans and into the prepuce, but on account of the sensitiveness of this region to the entrance of a needle, it is much better to give these patients ether, as that allows of much better work being done. The prepuce is first stripped away from the glans with the handle of the scalpel until the corona is free. The prepuce is then split through the middle and the folds on either side of the glans are picked up with a pair of thumb forceps and cut off with scissors. Enough must be cut off to prevent re-adhesion between the glans and any remaining prepuce. It is not worth while to stop the oozing of blood which follows the operation, as that will soon cease spontaneously. Aristol is dusted on the wound daily until it has healed. It is not always an easy matter to strip a *glans clitoridis* from preputial adhesions, and incomplete work by one who has not a clear idea of the appearance of the normal glans will result in disappointment. This work should be done by women physicians whenever it is possible to obtain their services.

THE MECHANISM AND ANATOMY OF SUBLUXATION OF THE HEAD OF THE RADIUS.

In order to verify a theory which had already been accepted by some as tenable in reference to the anatomy of that common injury of childhood known as subluxation of the head of the radius, I made the following experiments :

Two arms from a child four months of age, and two arms from a child fourteen months of age, both children dead a few hours, were placed in a weak acidulated bichloride of mercury solution, and the experiments were made during the next twenty-four hours.

Fig. 50.—Orbicular ligament in normal position.

Fig. 51.—Orbicular ligament slipped between head of radius and capitellum.

Experiment No. 1. Left arm of four-months-old child—all muscles dissected apart from each other, but not removed, and ligaments of elbow freely exposed. Traction with the hands was made upon the radius and humerus simultaneously, and with varying degrees of force.

Observation. Separation of head of radius from capitellum, and of head of ulna from trochlea ; depression of ligaments into joint space as a result of atmospheric pressure ; spontaneous restoration of all

structures to their normal position immediately upon being relieved from traction force. Subluxation not produced.

Experiment No. 2. The same arm ; all muscles removed. Repeated traction was made upon the radius and ulna with the bones of the arm in various positions of flexion and rotation.

Observation. The same as in experiment No. 1.

Experiment No. 3. Right arm of fourteen-months old child; muscles of arm removed with exception of biceps ; simultaneous traction upon radius and humerus.

Observation. Separation of articular surfaces of radius and ulna from capitellum and trochlea ; depression of ligaments into joint space; sudden slipping of loop of orbicular ligament over head of radius, and into joint space between head of radius and capitellum ; orbicular loop remains interposed between head of radius and capitellum when traction force is discontinued ; articular surfaces of head of ulna and trochlea remain slightly separated because of the ligamentous wedge made by the orbicular loop between radial head and capitellnm. Subluxation produced. Slight apparent deformity. A clicking sound is produced by rocking the articular surfaces of the ulna and humerus together. The joint movements are almost complete, but flexion is slightly limited through the last few degrees of range. Reduction of the orbicular ligament is difficult, but is finally accomplished by rotating the radius into pronation and pressing the joint surfaces together at the same time. The reduction is sudden, and takes place with an audible snap. There is then restoration of all structures to their normal positions, but the orbicular ligament appears to be more loosely attached to the surroundings than before on account of the stretching of its connective-tissue attachments.

Experiment No. 4. Same arm ; radius and ulna held in my left hand, and humerus in my right hand. The specimen was held with its elbow in an extended or partially flexed position, and pressure was made with my thumb on the outer surface of the head of the radius, forcing it slightly away from the capitellum, and mesially toward the ulna.

Observation. Subluxation of the head of the radius is produced in the same anatomical way as when traction force was applied in the long axis of the radius.

Experiment No. 5. Same arm ; subluxation reduced ; biceps put upon the stretch in its normal axis of traction, and efforts then made to produce subluxation by traction upon the radius and humerus with my hands, and by pressure upon the outer surface of the head of the radius with my thumb.

Observation. It is at once apparent that subluxation of the head of

the radius cannot be produced by any mechanism while the biceps muscle is at work.

Experiment No. 6. Left arm of the four-months-old child. Subluxation was produced after more violent movements of traction and of outer side pressure than I had applied at first.

Experiment No. 7. Right arm of four-months-old child. All muscles were removed excepting the brachialis anticus and supinator brevis. Simultaneous traction upon the radius and humerus produced subluxation of the head of the radius, and a few fibres of both of the muscles were drawn down into the joint space between the radical head and the capitellum, along with the orbicular ligament and a part of the anterior ligament. The subluxation was reduced most easily by strong pronation of the radius, very slight flexion of the elbow, and upward pressure in the long axis of the radius. As reduction of the head of the radius is supposed to occur spontaneously after a few days in many cases, it seemed to me that such reduction could take place only as a result of synovitis, with increase of synovial fluid, and the consequent forcing of the orbicular ligament out of the joint space.

For testimony bearing upon this point, I made the following trial :

Experiment No. 8. Right arm of four-months-old child. Subluxation produced. About forty minims of water were injected into the joint cavity through a fine hypodermic needle.

Observation. Tension of the capsule, quick and strong flexion of the forearm upon the arm, and pronation of the forearm, made by pressure of the injected water. Orbicular ligament remains hopelessly locked within the joint space between the head of the radius and capitellum. Condition less favorable for spontaneous reduction than when the joint was empty of water.

Experiment No. 9. Left arm of fourteen-months-old child. Muscles dissected away from each other, but not removed. Attempts were made at producing subluxation by pressure with the thumbs upon the outer surface of the head of the radius, and resulted in ordinary luxation of the head of the radius anteriorly. The head of the radius tore through the anterior ligament proximally to the orbicular ligament.

Conclusions from these nine experiments.

(1) Subluxation of the head of the radius consists in the separation of the head of the radius from the capitellum by the interposition between them of a loop of the orbicular ligament, which is accompanied in some cases by a small portion of the anterior ligament of the elbow, and some fibres of the brachialis anticus and supinator brevis muscles. The articular surfaces of the head of the ulna and of the trochlea remain slightly separated at the time, because of the wedge of orbicu-

lar ligament between the head of the radius and the capitellum. Passive movements of the joints give rise to clicking sounds, caused by the rocking together of the separated ulnar and humeral articular surfaces. There is no appreciable deformity on inspection or palpation, but the range of motion of the forearm upon the arm is slightly limited.

(2) The accident occurs at an instant when the biceps muscle is relaxed, and as a result of direct traction force upon the radius while the forearm is in a position of partial or complete supination. It also occurs under the same anatomical conditions when the force is applied directly to the outer side of the radius, forcing the head of the radius anteriorly and a little proximally from the humerus. The former mechanism is brought into play when a child, led by the hand, stumbles and falls, its hand remaining grasped in the hand of the nurse. The latter mechanism is brought into play when in a fall the outer side of the elbow strikes a stone.

(3) The mechanism of spontaneous reduction has not been determined. It may occur as a result of swelling of the pinched ligaments and muscular fibres, but it is more likely to be due to absorption of the portion of loop which is subjected to the greatest degree of tension and of pressure. A strand of catgut under the same circumstances would be absorbed in a few days.

(4) Reduction may be accomplished by the surgeon, as a result of various movements which tend to work the head of the radius back under the loop of orbicular ligament, and the most frequently successful movement seems to be pronation and pressure directed proximally along the long axis of the radius, the arm being at the time completely extended. An audible snap gives evidence of reduction.

(5) In treating cases in which reduction cannot be accomplished by the surgeon, the arm should be fixed in a position of nearly complete extension, as this gives the loop of orbicular ligament the best opportunity to escape according to the testimony of my small number of specimens.

(6) The muscular disability of the arm during the early days of the injury is apparent rather than real, as I have demonstrated in one adult patient who made intelligent observations. Because of the pain consequent upon movements at the elbow joint the patient could with difficulty be persuaded to move the arm at all, but movements once begun, she could carry the forearm through almost its complete range of motion.

(7) An injury which has for its principal feature a displaced orbicular ligament, would be correctly described as "dislocation of the orbicular ligament" rather than as "subluxation of the head of the radius."

POTT'S FRACTURE, AND THE FRACTURE OF THE FIBULA WHICH FOLLOWS ADDUCTION OF THE FOOT.

THE following experiments were made for verification of theories which are subject to variance among authors as to the mechanism which is involved. Pott's fracture is not so common as fracture following adduction of the foot, and yet the two are apt to be confused unless the surgeon on inquiry learns from the patient whether the foot "turned in or out." The large proportion of fractures which are recorded in clinical history books as cases of Pott's fracture, are really cases of fracture by adduction of the foot.

Pott's fracture occurs when the foot "turns out," and fracture by adduction of the foot, when it "turns in." In making experiments at the morgue, cadavers of people of various ages were employed, and usually with adults not more than two days after death. The soft parts about the ankles were dissected away excepting the ligaments and tendons, and in some of these a little window was cut in the anterior ligament of the ankle joint. A stout piece of board was bound very firmly to the sole of the foot, leaving space to pass a broom-handle between the sole and the board for use as a lever. Fractures were then made by turning the foot quickly and violently in one direction or the other by means of the broom-handle grasped in my hands, or by standing the cadaver erect upon the abducted or adducted foot, and applying force by pressing the cadaver downward until structures near the ankle gave way.

The mechanism of Pott's fracture was observed to be as follows in a series of cases: When the foot was turned outward (abducted) with a sufficient degree of violence, the astragalus rotated from without inward on its antero-posterior axis, and at that instant the tibia assumed the position of an opposing lever, the short arm of which was the internal malleolus, the long arm the shaft of the tibia, and the fulcrum was composed of the astragalus and os calcis, which retained their relative positions with each other. The principal object upon which this lever acted was the deltoid liga-

ment, and the ligament in some cases tore transversely, in other cases it pulled off the tip of the short arm of the lever (the internal malleolus). Ligamentous resistance then being overcome, the external surface of the os calcis struck the tip of the internal malleolus, but transmitted no breaking force along the fibula. The fibula broke because of continued exertion of force, and usually at a point varying from two to four inches from the tip of the malleolus. When a man breaks his fibula, then, in sustaining a Pott's fracture, he breaks it after the deltoid ligament has lost its hold, and because the weight of the body is then transferred from the tibia to the fibula.

The common fracture near the distal end of the fibula by adduction, on the other hand, occurs as the result of an entirely different mechanism from that of Pott's fracture. When the foot of the cadaver was turned in (adducted) with a sufficient degree of violence, the fibula was fractured, usually a little nearer to the tip of the malleolus than in Pott's fracture. Adduction force being applied, the astragalus rotated from within outward on its antero-posterior axis until limited in its rotation by the simultaneous impinging of its superior external border against the external malleolus, and of its inferior internal border against the internal malleolus. In order that rotation be continued, the two malleoli need then an increased distance between them ; but the five ligaments—the inferior interosseous, the anterior inferior interosseous, the anterior inferior and posterior inferior tibio-fibular, and the transverse—prevent separation at the inferior tibio-fibular articulation, and consequently, the required space can be gained only through fracture of one or both of the bony barriers (the malleoli) This regularly occurred in one, the external malleolus, or in the fibula just above the malleolus, allowing the malleolus to be pushed outward by rotating the astragalus. Such was the injury that occurred regularly in the experiments, but occasionally both malleoli snapped simultaneously when forcible adduction was made, and in such cases in practice, the diagnostic point for Pott's fracture—tenderness at the inner side of the ankle—would not be a differential point unless we determined that the point of fracture of the internal malleolus was near the tibia, as it usually is in Pott's fracture, or near the junction with the shaft, as it usually is in fracture of the fibula by adduction of the foot. The patient ordinarily remembers vividly whether the foot turned in or out at the time of the injury. In practice, we can pick out the line of

fracture by pressing on the skin over the bone with the end of a lead-pencil. The exact line of fracture can be determined in this way in any bone that is near the surface, the patient experiencing acute pain when the end of the lead-pencil touches the skin over the crack in the bone, but not when the pressure is made a quarter of an inch away. In fracture of the fibula by adduction of the foot, when the shaft of the fibula is broken at a point sufficiently far from the malleolus, the ends of the fragments bear about the same relation to each other that they do after Pott's fracture, and there is a depression in the soft parts over the seat of injury. The tilting outward of the external malleolus gives to the front of the ankle at the same time a broadened appearance. There is little displacement of the foot after this fracture by adduction, unless both tibia and fibula have suffered injury, but in the latter case the deformity is the same as that which accompanies Pott's fracture, the foot having a tendency to remain in an abducted and everted position by virtue of the action of the peroneus longus muscle, and the proximal end of the distal fragment of the fibula usually lies to the inner side of the distal end of the proximal fragment of the fibula. If there is much unreducible deformity about the ankle, it is well to cut down upon and wire the ends of the fragments. This I have done when the deformity was extreme in degree, for the ankle joint is not a good joint unless it is a good hinge, and many college athletes who suffer fracture near the ankle need a perfect hinge.

The proportion of fractures by adduction or by abduction is shown in a consecutive series of nineteen cases which I have previously published, viz.: six occurred by the mechanism of Pott's fracture; in two the mechanism was undetermined; and the rest suffered fracture of the fibula from adduction of the foot.

THE DOWEL-PIN IN DISLOCATION OF THE ACROMIAL END OF THE CLAVICLE.

In two cases of dislocation at the acromial end of the clavicle I made a long incision over the seat of injury, drilled the articular surfaces of the acromion process and the opposed end of the

Fig. 52.—Dislocation of acromial end of clavicle. Right shoulder broadened and drooping. End of clavicle projecting beneath skin.

clavicle, and inserted a stiff silver dowel-pin, about one inch in length, into the drill holes. The two articular surfaces were then pushed together, and remained easily in normal position, held by

the dowel-pin. Catgut sutures were used for uniting the ruptured rhomboid and trapezoid ligaments. In one case, the injury had occurred a week previously. A photograph from this case before operation, shows the projecting acromial end of the clavicle, and the drooping and broadened right shoulder. The companion photograph, taken about eight weeks after operation, shows the effect of repairing the shoulder girdle, the shoulder being normal

FIG. 53.—Dislocation of clavicle repaired by means of dowel-pin.

in appearance, except for a wasting of the trapezius and deltoid muscles, which became perfectly normal two months later. Six months after the operation, although the acromio-clavicular articulation was immovably ankylosed, this patient carried on violent gymnasium exercises, and took his place in a college boat crew without further trouble. The movements of the shoulder are only slightly limited, because the repaired shoulder girdle is used

as a whole more freely than the left one. In the other case, which was a dislocation of the left clavicle and of long standing, there was a complication consisting of a fracture of the clavicle near the acromial end, which had united in a somewhat angular position. In this case, a shoulder without deformity, excepting for the fracture angle, was obtained. There is firm ankylosis but some disability, the arm not being quite as strong as the right one, although perfectly useful for all ordinary purposes. Nearly a year was required for restoring the wasted trapezius and deltoid muscles to a normal condition, by the use of massage, electricity, and strychnine injections in this second case.

THE DOWEL-PIN IN FRACTURE OF THE CLAVICLE.

THE dowel-pin was employed in one of my cases of fracture of the clavicle, and this resource will be of value in other cases in which deformity is particularly to be avoided, as in cases of fracture of the clavicle in young women.

In the case in question, an oblique fracture at the junction of the outer and middle thirds of the left clavicle of a muscular man would not permit of retention of the fragments in position. An impromptu dowel-pin was made from the silver bar of a watch chain. An incision not more than an inch in length was made through the skin. The outer fragment of the clavicle was first lifted with narrow volsella forceps, and the dowel-pin having been pushed for half its length into the cancellous structure of this

FIG. 54.—Dowel-pin in fractured clavicle.

fragment, the projecting remaining half of the pin was allowed to sink into a little slot cut into the anterior surface of the other fragment with a small chisel. The wound healed by primary union, and at the end of four weeks the patient resumed the free use of his arms in his work as a laborer. There was not the slightest trace of deformity, and the scar was barely apparent. A skin incision, half an inch in length, would have answered for this operation. An evanescent scar can be obtained in such cases by the technique which is employed for obtaining such a scar in an appendicitis operation. (See description of this technique under Appendicitis.)

MALLET-FINGER.

THE deformity here described is not uncommon among men who engage in athletic sports.

When the extensor tendons of the fingers are tense, a blow upon the end of a finger transmitting force in a direction which would ordinarily flex the finger, results in injury to the extensor tendon in the vicinity of its attachment to the dorsal surface of the last phalanx. The injury consists, not in a bodily separation of the tendon from its points of attachment, but rather in a thinning of the tendon proximally from the principal point of attach-

FIG. 55.—Mallet-finger. Permanent flexion of tip of index-finger.

ment to the phalanx, and from the fibres that form the posterior ligament of the last pharyngeal articulation. A few fibres of the tendons are undoubtedly ruptured, but most of them slide away from each other very much as the threads of a textile fabric separate when the fabric is violently stretched, but not torn, the structure retaining its original general appearance.

Immediately after the occurrence of the injury to the tendon the last phalanx of the finger assumes a semi-flexed position, and the deformity is usually permanent, the extensor tendon then having little or no influence upon the freed phalanx. Aside from the uncanny appearance of such a finger, the deformity is a source of much annoyance to the patient.

The tendon is repaired without much difficulty by making a longitudinal incision two centimetres in length over the site of the injury, dividing the thinned tendon longitudinally into the two principal fasciculi into which it naturally separates, dividing the

FIG. 56.—Extensor tendon of index-finger thinned at point of attachment by artificial production of mallet-finger upon the cadaver.

tendon transversely, proximally from the thinnest point, and advancing each fasciculus to a point upon its own side of the finger, near the base of the finger-nail. At this point the fasciculus is sutured to the under surface of the skin with a suture which

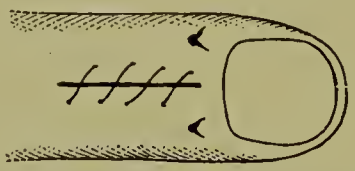

FIG. 57.—End of index-finger, showing line of incision and sutures. Two black dots mark sutures uniting fasciculi and skin.

passes through the skin and is tied upon the outside. The fasciculi are sutured to skin rather than to periosteum and tendinous remains, because the former structure affords a firmer hold and the cut end of the tendon makes as good union with the phalanx as it would if sutured directly to periosteum.

The finger-nail is sometimes lost temporarily as a result of the operative disturbance near its matrix.

When the advanced fasciculi are sutured in place there is an over-correction of the deformity of the phalanx, which causes

FIG. 58.—Temporary flexion at middle phalangeal articulation after advancement of extensor tendon.

also a flexion at the middle phalangeal articulation. This condition is temporary, and disappears spontaneously in a few weeks, leaving a perfect finger.

TWO CASES OF CONSERVATIVE SURGERY OF THE ARM.

A YOUNG woman, twenty years of age, caught her fingers between hot rollers in a laundry and the right hand and arm were drawn into the machine and destroyed to the bone wherever the tissues were held in contact with the rollers. The structures that escaped were three fingers and about one fifth of the hand, a narrow strip of skin along the ulna, barely an inch wide, and the tissues between that strip of skin and the

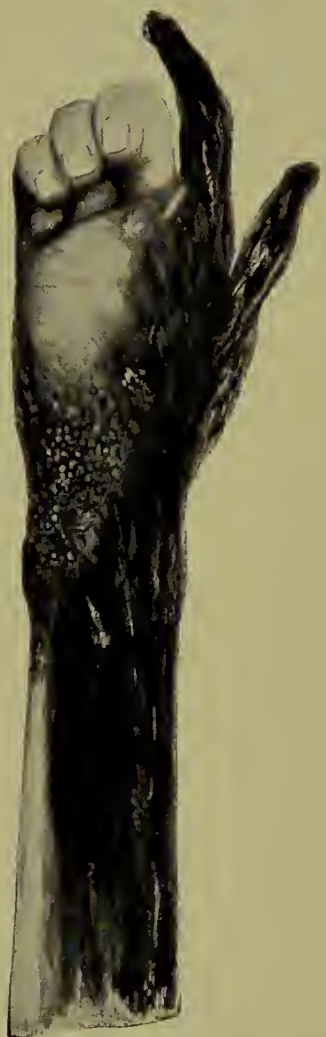

FIG. 59.—Burned and sphacelated hand and arm.

FIG. 60.—Sphacelated region excised.

interosseous ligament, carrying the posterior interosseous artery. All other structures were destroyed, and they sloughed away for the greater

part leaving the bones of the forearm and wrist bare. Where the burned tissues did not slough away they dried and clung to the bone. There was no sensation below the proximal portion of the spared strip of skin along the ulna. I excised the destroyed parts by cutting away the dried forefinger and thumb, and sawing transversely through all of the metatarsal bones at the distal portion of the injury, and through the radius and ulna at the proximal end of the injury, being careful to lift the strip of skin and the tissues carrying the interosseous artery out of the way before excising the bones. The soft parts at the lines of excision were cut transversely across, and very neatly, in order to

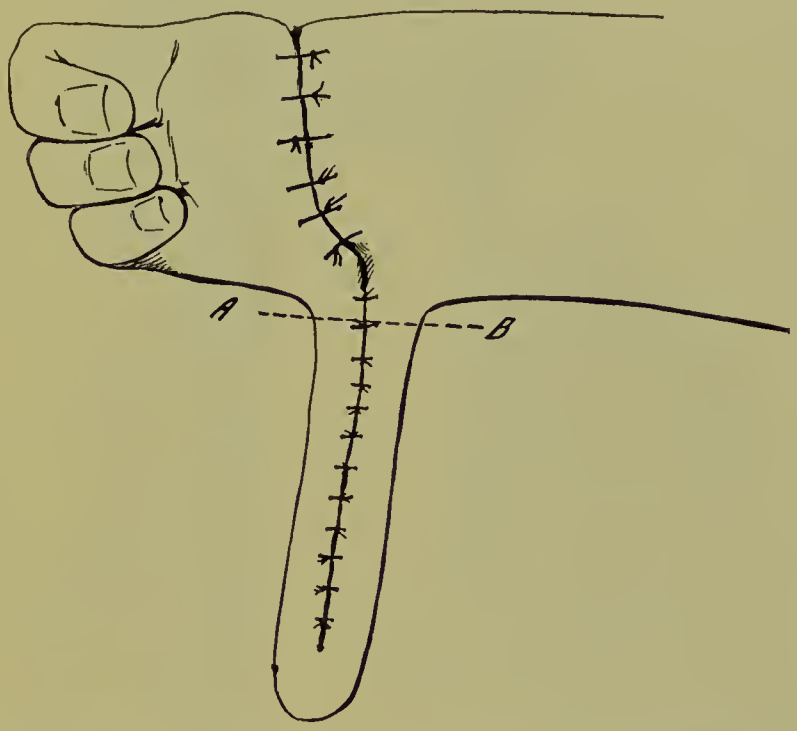

FIG. 61.—Fingers transplanted to arm. Loop carrying interosseous artery.

ensure good union of tissues if the small arterial connection should prove equal to the task. The portion of hand bearing the three living fingers was then carried up to the stump of arm, and ends of metacarpal bones were placed in contact with the ends of radius and ulna. The flexor tendon of the third finger was sutured to the flexor carpi radialis muscle. The flexor tendon of the fourth finger was sutured to palmaris longus. The flexor tendon of the fifth finger was sutured to flexor carpi ulnaris. The reason why these connections were made instead of the natural ones was because I had to choose the most useful-looking structures of the arm stump, and selected muscles in which tendinous bands gave prospect of forming a union with finger tendons. The extensor tendons of the fingers were sutured to various fascial

bands, there being little opportunity to make definite connections. When the fingers had thus been sutured to the arm the ribbon of tissue carrying the interosseous artery stood out in the form of a loop several inches high. All skin margins were sutured and the loop of tissue was loosely packed in gauze in such a way as to avoid compres-

FIG. 62.—Repair completed. Both arms placed side by side for comparison. From photographs several months after operation.

sion or angulation. The dressing applied was the customary permanent one. The entire wound healed by primary union under this one dressing, and about two months later I cut away the loop carying the artery, having first determined that the fingers showed signs of circulation of blood while the loop was compressed firmly to cut off circulation by that route. I had not expected that sensation would return in the fingers, but believed that the fingers would, nevertheless, be more use-

ful than an artificial hand. Sensation began to appear, however, in the fingers about three months after the operation, and the ability to distinguish heat from cold, the patient thinks, returned simultaneously with the sense of touch. Sensation began first in the little finger, and four months from the date of operation it seemed to be almost normal in degree in all of the fingers. The patient with eyes closed could not tell instantly which finger or what part of a finger was touched or pricked, although the sensation was instantly transmitted to the brain. Several seconds later she could localize the point at which contact was being made. The nails of the three fingers grew normally.

FIG. 63.—Destruction of tissues of right arm.

The flexor tendons made excellent connection at their points of suture, but the extensor tendons made a feeble connection, so that the fingers remained flexed, but could be voluntarily extended a little *en masse*. Flexion was strongly made *en masse*, but the patient could not distinctly move each finger separately. Flexion could be made with sufficient degree of force to hold the handle of a brush or comb or knife, and the fingers were useful enough for such purposes, but the patient was a sensitive girl who was so much mortified at the interest shown in her uncanny deformity by friends and by strangers that she begged to have the fingers amputated so that she could wear a false arm and hand that would look more attractive. With much regret I complied with her demand about a year later and amputated through the stump of the

arm on the proximal side of the scar, preserving in the specimen all of the connections that had been made between united tendons and nerves. I have not felt sufficiently expert to make such a dissection of the specimen as it deserves, and await the request of some anatomist at whose disposal it can be placed.

FIG. 64.—Arm repaired. Both arms placed together for comparison. From photograph several years after operation.

In another case a youth about fifteen years of age caught his right arm between a belt and a swiftly revolving wheel which almost completely destroyed the involved portion of the arm (Fig. 63). Splintering the radius and ulna, tearing away soft structures, and leaving a narrow strip of tissue which carried the ulnar artery intact, but which was ground full of oil and shop dirt. More than two hours of time were required for trimming and uniting injured structures, and an inch or more of ulna had to be resected later at a second operation. Although the injured arm is crooked, and four inches shorter than its fellow, it is practically a normal arm, and with it the patient plays the violin and does all ordinary work. If I had resected an extra inch of the radius and ulna at the first operation, non-union of the ulna would have been avoided and the arm would not have been crooked.

SKIN GRAFTING FROM BLISTERS.

SKIN grafts for application according to the method of Thiersch may be obtained from blisters. The idea of using grafts of this sort first occurred to me while treating burns in which large blebs had formed. After securing and cleansing the separated cuticle

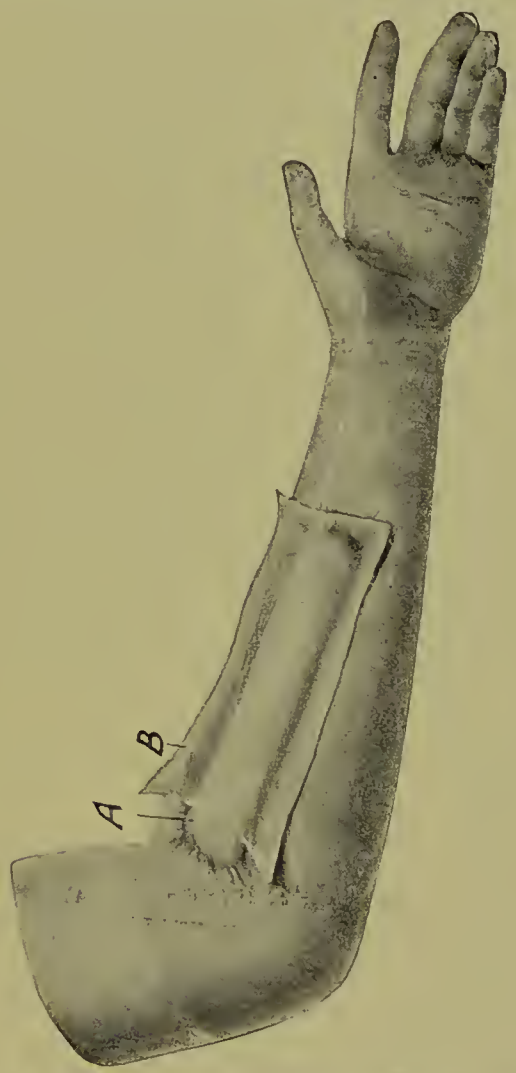

FIG. 65.—A. Blister. B. Gutta-percha tissue for making a roll with separated cuticle.

in physiological saline solution it was replaced upon the sterilized wound where it adhered well in cases in which the skin had not been subjected to a destructive degree of heat. Since that time

I have obtained blister grafts and have applied them successfully to small wounds. The new epithelium which covers the site of a blister graft is more delicate than a Thiersch graft covering, and consequently is not so desirable for large wounds. Sometimes the blister graft does not become adherent, but conducts new epithelium across the wound so rapidly that repair is completed under one dressing, in cases which would otherwise require several weeks for granulation. My plan of procedure consists in sterilizing the skin from which a graft is to be taken, and then raising a blister of the desired shape and size with cantharides. The blister cuticle is snipped away by cutting around its margins. A piece of gutta-percha tissue is laid upon the graft and gutta-percha and graft are rolled up together, making a compact roll which is easily handled. The graft is then transferred to the wound and unrolled upon it, leaving the gutta-percha tissue in place. The preparation of the wound, and the after-treatment, are conducted according to Thiersch's method, bearing well in mind the fact that any chemical antiseptics which have been employed for sterilizing the wound must be removed by flushing with physiological saline solution before the graft is applied. The gutta-percha tissue is not removed from the graft for ten days or two weeks, but sometimes the outer dressing will need changing if it becomes too dry and hard. An attached blister graft sometimes becomes several times thicker than the cuticle at the time when it was transplanted, but I have not as yet made a microscopic section of such thickened tissue to determine the nature of its structure.

PHELPS' HARE-LIP OPERATION IN TWO STEPS.

THE prettiest hare-lip operation with which I am familiar is that of Dr. Phelps, which places the scar in the middle line of the lip, with no deviation of any part of the scar to either side of the middle line. This result is accomplished, if the fissure is to the right of the middle line, by making another similar fissure to the left of the middle line with a pair of scissors, and then cutting out the intervening tissues between the two fissures, and joining the walls of the fissures in the middle line. It is a case in which two equal wrongs make one right. A "V" of lip, with its base at the septum of the nose, can be saved if we wish, when the piece of lip between the two fissures is cut out.

Because of the loss of tissue in the Phelps operation, it is unfortunately confined to a comparatively small proportion of cases, making too flat a lip in cases which require removal of much tissue, but I have made it applicable to a larger class by first repairing a hare-lip fissure by the old-fashioned straight-line method, and then waiting a few months to allow the orbicularis muscle to draw the scar nearer to the middle line, as it may be expected to do. The scar will very often be drawn to a point not more than one fourth of the distance from the middle line of the lip to the angle of the mouth on that side, and then the second fissure can be made and the scar placed in the middle line. There are very many patients about the country who are carrying hare-lip scars that are a source of mortification to them, but whose scars can be placed in the middle line where they will not attract attention. The cheeks should be well loosened from their attachments to the superior maxillary bone if we wish to have the orbicularis muscle take up enough of the lower lip to lengthen a short repaired upper lip. New angles of the mouth will then form.

At this point I will add a note on another plastic operation which has no connection with hare-lip. One of my repaired noses could not be supported because there was no septum. A most excellent septum was made by turning up a large flap of lip, extending from the nose to the mouth, and suturing it to the interior of

the nose where the septum was needed. The margins of the wound of the lip were then united, just as they are after the mid-line hare-lip operation. The septum is satisfactory in this case.

DISTENSION OF FISTULOUS PIPES WITH PLASTER OF PARIS TO FACILITATE THEIR REMOVAL.

In several of my cases of fistula in ano, and in one case of long, tortuous fistula of the plantar region, plaster of Paris was injected into the fistulous tracts, and allowed to set. Guided by the rigid plaster, it was then an easy matter to dissect out a fistulous pipe in its entirety, and muscles which were divided in following the pipe were closely sutured for primary union. Plaster of Paris will not set if any pus or blood remain in the fistulous tract, and the resource cannot be applied except in cases in which we can perfectly cleanse the tract first with peroxide of hydrogen and saline solution. After this has been done, a small glass syringe is loaded with well salted plaster, prepared as for making a cast, and before the plaster begins to thicken the contents of the syringe are injected forcibly into the fistula, pressing the nozzle of the syringe closely against one opening, and closing any other opening with the end of the finger. The syringe and the finger which closes the opening must be kept in place for a few minutes until the plaster has set. The time can be determined by watching any plaster which remains in the syringe. The syringe is then thrown away, and the pipe, distended with a very hard core of plaster, is dissected out.

It is not necessary to apply this resource in most of our cases of fistula, but it is sometimes very useful.

PREVENTION OF ABORTION BY REMOVAL OF A UTERINE FIBROID.

A patient thirty-two years of age in the fourth month of her first pregnancy began to have symptoms of a threatened abortion, uterine contractions occurring at intervals of about fifteen minutes. Opium, hot fomentations, and posture failed to stop the symptoms. On examination by palpation through the abdominal walls I found a sessile subperitoneal uterine fibroid about as large as a man's fist situated upon the fundus of the uterus near the right oviduct. The abdomen was opened, and the tumor removed by enucleation. The wound in the uterus, about five inches in length, but not penetrating, was closed with a continuous suture of catgut. Uterine contractions ceased at once, and a normal child was born at full term.

REDUCTION OF AN INVERTED UTERUS BY INCISING THE CONSTRICTING RING INTRA-ABDOMINALLY.

A PATIENT, twenty-four years of age, had a complete inversion of the uterus after parturition. Packing of the vagina for two months, by the family physician, had allowed good involution to take place, but it was found to be impossible to relieve the inversion by way of the vagina. I made an abdominal incision in order to effect reduction bimanually and by internal dilatation of the constricting cervix. This failing, the entrapped bladder and uterine adnexa were drawn out of the way, and the uterine wall and the ring of cervix were divided with a long scalpel. The inversion was then easily reduced. I had been tempted to divide the constriction from the vaginal side, but when the abdomen was opened it was observed that the bladder or vessels of the broad ligament would have been cut if that procedure had been attempted.

HYSTERECTOMY FOR PLACENTA PREVIA.

A WOMAN, thirty-four years of age, in the fifth month of pregnancy, suddenly had an alarming hemorrhage from the uterus, which stopped spontaneously, with the exception of a little oozing. On examination it was determined that one margin of the placenta was apparently so near the cervical region that it had become separated through unequal expansion of the uterus, although the case was not one of well marked placenta previa. I planned to dilate the cervix rapidly, and get past the placenta in time to deliver the child before hemorrhage could prove fatal, but one of the consultants had been present at two deaths resulting from this plan of management. In both cases an attempt was made to hold the separated margin of placenta against the uterine wall with a finger in order to stop hemorrhage by compression while dilatation was being effected, but in both cases the blood, thus being prevented from escaping, instantly dissected off the whole placenta, and the patients died on the table. I feared to dilate, but knew that abdominal hysterectomy would be a safe procedure, and this was consequently done, the uterus with its contained fetus being removed in one mass. The patient recovered without complications.

OVARIAN TRANSPLANTATION.

WITHIN the past four months I have tried the plan of transplanting a segment of normal ovary from one woman to the uterus or oviduct of another woman, in cases in which the uterine adnexa had been removed for disease, and in cases of infantile uterus with rudimentary adnexa.

In another class of cases in which the adnexa had been rendered useless by disease, but in which a portion of at least one ovary was good, I have transplanted that piece of ovary into the patient's own uterus or oviduct.

It is perhaps premature to describe these plans before practical results have been obtained, but the procedure is rational if we can judge from the well-known fact that transplanted portions of other organs continue in their function, and the operative work is so easily carried out that it seems best to describe certain practical points that make it easy, but which have had to be learned by experience.

In transplanting ovary from one woman to another there is abundant opportunity in hospital practice where it is not difficult to arrange for operation upon two or more patients in the same hour, and one woman whose ovaries contain normal tissue can spare for the other woman a segment of ovary as large as a pea without suffering any real loss. The method which I have found to be best consists in removing from the normal ovary a segment about as large as a pea and placing it in warm physiological saline solution, temporarily. The fundus of the uterus that is to receive this piece of ovary is then split transversely down to the lumen. The piece of ovary is introduced into the slit in the uterus in such a way that peritoneal surface of ovary will rest against endometrium of uterus and raw surface of ovary remains in contact with raw surface of uterus, and is fastened in place by a fine catgut suture that serves at the same time to partially close the slit in the uterus. Other sutures that are necessary for closing the wound are introduced, and a drainage wick of gauze

is placed in the uterine canal leading out through the vagina into a receiving mass of gauze at the vulva. The fundus of the

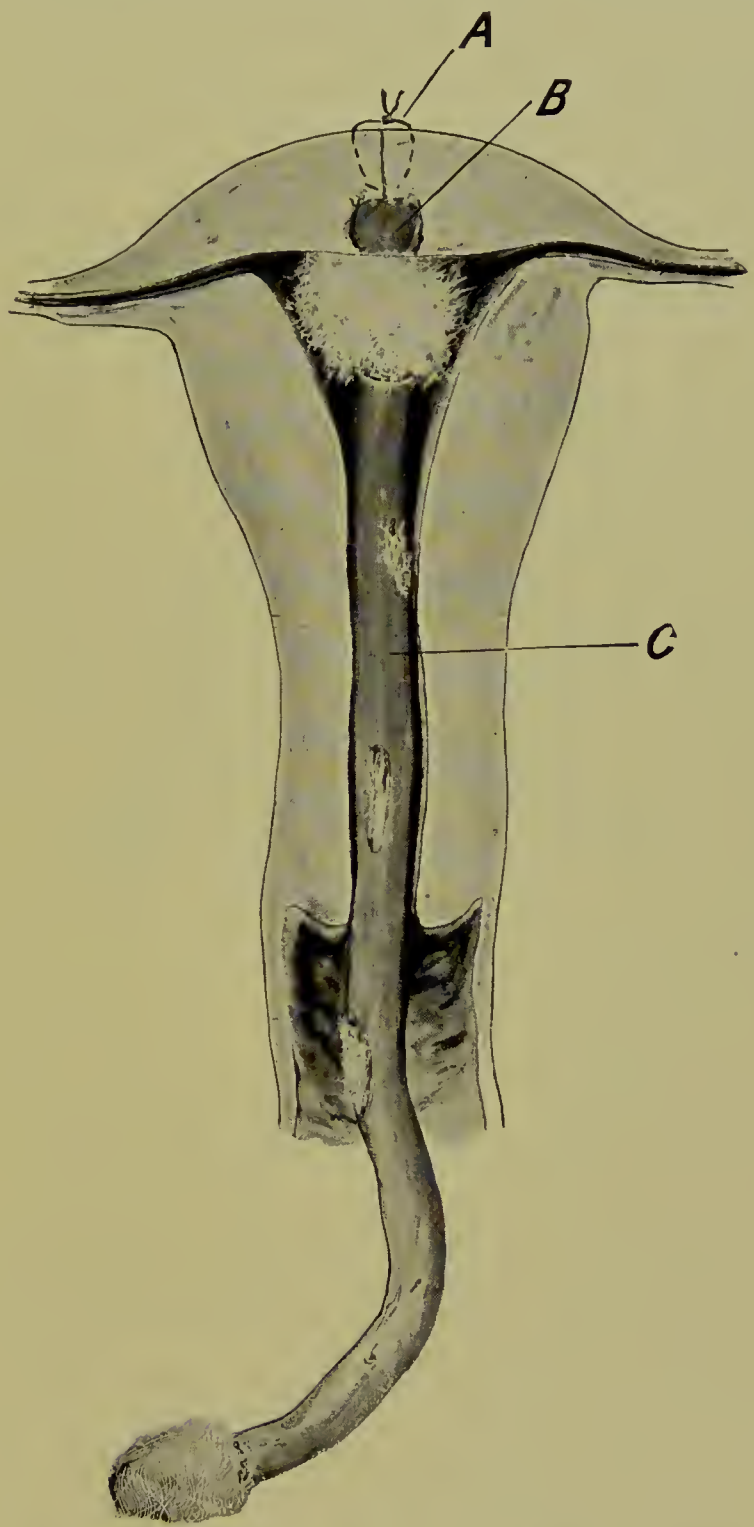

FIG. 66.—A.—Suture of slit through which graft was inserted.
B.—Ovarian graft.
C.—Drainage wick.

uterus that is to receive a graft is reached by way of an anterior abdominal incision or preferably by way of the vagina through a button-hole opening into Douglas' *cul de sac*. The fundus is readily turned down into the vagina, and after receiving the graft is turned back into the abdomen again, and the patient is then ready to get out of bed in two or three days. The gauze drain from the uterus is removed at the end of forty-eight hours after the operation and the case should require little further treatment.

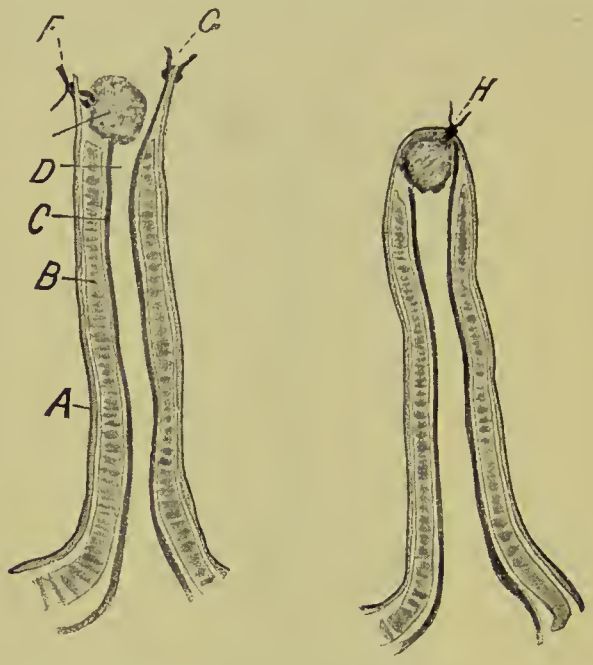

FIG. 67—A.—Peritoneum of oviduct.
B.—Muscularis.
C.—Mucosa.
D.—Lumen.
E.—Segment of transplanted ovary.
F.—Suture for holding segment of ovary.
G.—Suture for keeping mucosa and serosa together.
H.—Suture for closing end of oviduct.

In cases in which the oviduct is chosen as the place for inserting an ovarian graft, it is difficult to find the lumen of the tube if the latter has been cut short, because the muscular sheath contracts and inverts margins of the mucous tube. Before attempting to insert the graft in such a case it is best to pass a probe through the lumen of the oviduct into the uterus first and then amputate the oviduct about the probe, suturing mucosa and peritoneum together at any one point in the circular cut before completing the division. This will prevent inversion of mucosa

when the muscularis contracts and will allow us to keep the graft in contact with mucosa later so that ova can escape into the lumen of the oviduct. The next step consists in dilating the stump of oviduct up to the point of paralysis of its muscularis so that further work can be done more easily. The segment of ovary that is to be engrafted is then taken out of the warm saline solution and its raw surface is sutured with one strand of finest catgut to the raw surface of the oviduct in such a way that these two raw surfaces will adhere to each other and allow normal surface of ovary to project into the lumen of the oviduct when the final step is taken of closing the abdominal end of the oviduct.

Some patients object to the idea of carrying a piece of ovary from another woman, as the child from such a case would have treble parentage, but there are many women whose uterine adnexa have been removed who grasp at any opportunity for bearing children, and whose minds are much relieved at the thought of the possibility of such a prospect. It is not improbable that menstruation and normal sexual impulse may continue in women who carry an ovarian graft, and I shall obtain full testimony bearing upon this point.

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